

# SILVER HALIDE PHOTOGRAPHIC LIGHT-SENSITIVE MATERIAL

## BACKGROUND OF THE INVENTION

### Field of the Invention

5        The present invention relates to a silver halide photographic light-sensitive material. In particular, the present invention relates to an ultrahigh contrast silver halide photographic light-sensitive material which is processed by using an image setter and automatic processor used for a  
10      photomechanical process.

### Description of the Background

As one of light exposure methods for photographic light-sensitive materials, the so-called scanner type image-forming method is known, in which an original is scanned, and light exposure is performed on a silver halide photographic light-sensitive material based on the image signals obtained by the scanning to form a negative or positive image corresponding to the original image. As light sources of light exposure apparatuses for this method, HeNe laser (633 nm), red semiconductor laser (670 nm to 680 nm) and LED (660 nm to 680 nm) are widely used. Further, when an image is directly printed on a printing plate without any reversal process after the image is outputted on a film from a scanner, or for a scanner light source having a soft beam profile, light-sensitive materials for scanners having a ultrahigh contrast property are desired. Furthermore, highly sensitive light-sensitive

materials are required in the scanning process in order to shorten the process, obtain high resolution and prolong the lifetime of the light source.

Meanwhile, various patent documents have been published 5 so far for sensitizing dyes exhibiting high sensitivity and little residual color when they are used with a HeNe light source or the like. Examples of such dyes include, for example, trinucleus cyanines (see, for example, Japanese Patent Laid-open Publication (KOKAI, henceforth referred to as "JP-A") No. 10 62-157057, JP-A-1-47449, JP-A-3-259135, JP-A-2-161424, JP-A-4-318542), trinucleus melocyanines (see, for example, JP-A-3-171135, JP-A-5-224330), trimethine cyanines (see, for example, JP-A-2-297541, JP-A-4-57046) and tetramethine melocyanines (see, for example, U.S. Patent No. 5,578,414). Further, light- 15 sensitive materials utilizing the aforementioned sensitizing dyes and a hydrazine derivative in combination have also been disclosed (see, for example, U.S. Patent No. 5,578,414, JP-A-6-194771, Japanese Patent Nos. 2926453 and 3086983).

In the development of the aforementioned light-sensitive 20 materials, it has become frequent to use an automatic processor in view of quick operation, simplicity and handling. In recent years, smaller replenishing amount, quicker operation and lower silver content of light-sensitive materials are increasingly strongly desired, and one of means for satisfying these 25 requirements is increase of activity of developer. In the processing of monochrome light-sensitive materials, the activity can be increased by using a higher concentration of

developing agent. However, there is a problem that degradation of the developer due to air oxidation becomes marked. Further, use of smaller thickness of light-sensitive material (for example, use of thinner protective layer) is also effective for 5 realizing quicker processing. However, if a light-sensitive material of a low silver content is quickly processed, there are caused a problem of residual color and a problem that fluctuations of photographic properties (dot % fluctuation, decrease of density etc.) become significant. Furthermore, a 10 lower silver bromide content in silver halide is also effective for attaining quicker processing. However, it suffers from a problem of generation of uneven processing by solution physical development, and thus use of a higher silver bromide content is development, and thus use of a higher silver bromide content is required.

15 Therefore, an object of the present invention is to provide a silver halide photographic light-sensitive material suitable for use with a scanner and image setter utilizing a HeNe laser, red semiconductor laser or LED as a light source, in which the problems of uneven processing and residual color 20 can be suppressed even after a long term running with a low silver content, and thus stable photographic performance can be obtained.

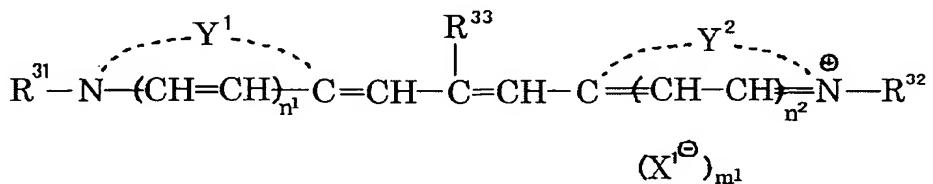
#### SUMMARY OF THE INVENTION

25 The inventors of the present invention conducted various researches, and as a result, they found that the aforementioned object could be achieved by the present invention having the

following characteristics.

That is, the present invention provides a silver halide photographic light-sensitive material comprising at least one silver halide emulsion layer and at least one hydrophilic 5 colloid layer on a support, wherein silver halide in the silver halide emulsion layer has a silver bromide content of 40 to 90 mol %, and the silver halide emulsion layer in the silver halide photographic light-sensitive material is spectrally sensitized with at least one kind of dye selected from dyes 10 represented by any one of the following formulas (I) to (IV):

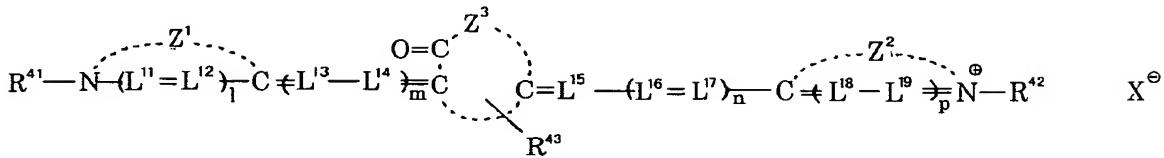
### Formula I



wherein, in the formula (I),  $Y^1$  and  $Y^2$  each independently  
15 represent a nonmetallic atom group required to form  
benzothiazole ring, benzoselenazole ring, naphthothiazole ring,  
naphthoselenazole ring or quinoline ring, where these  
heterocyclic rings may be substituted with a lower alkyl group,  
an alkoxy group, an aryl group, hydroxyl group, an  
20 alkoxycarbonyl group or a halogen atom,  $R^{31}$  and  $R^{32}$  each  
independently represent a lower alkyl group or an alkyl group  
having sulfo group or carboxyl group,  $R^{33}$  represents methyl  
group, ethyl group or propyl group,  $X^1$  represents an anion,  $n^1$   
and  $n^2$  each independently represent 0 or 1,  $m^1$  represents 1 or 2,

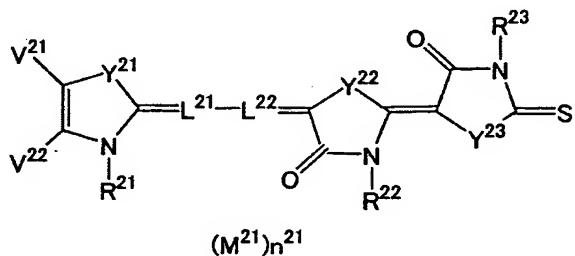
and  $m^1$  is 0 when an intramolecular salt is formed;

Formula II



5 wherein, in the formula (II), Z<sup>1</sup> and Z<sup>2</sup> each independently represent an atomic group required to form a 5- or 6-membered heterocyclic ring, Z<sup>3</sup> represents an atomic group required to form a 5- or 6-membered nitrogen-containing heterocyclic ring, which has a substituent (R<sup>43</sup>) on a nitrogen atom in Z<sup>3</sup>, R<sup>41</sup> and R<sup>42</sup> each independently represent an alkyl group, an alkenyl group, an aralkyl group or an aryl group, R<sup>43</sup> represents an alkyl group, an alkenyl group, an aralkyl group, an aryl group, a substituted amino group, amido group, imido group, an alkoxy group or a heterocyclic group, where at least one of R<sup>41</sup>, R<sup>42</sup> and R<sup>43</sup> represents a water-soluble group, L<sup>11</sup> to L<sup>19</sup> each independently represent a methine group, m and n each independently represent 0, 1 or 2, l and p each independently represent 0 or 1, and X represents a counter ion;

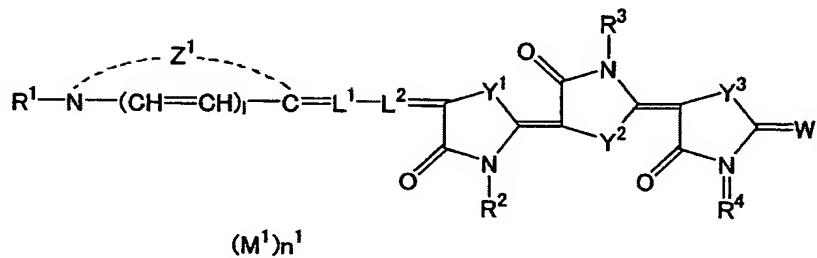
20 Formula III



wherein, in the formula (III),  $Y^{21}$ ,  $Y^{22}$  and  $Y^{23}$  each independently represent a  $-N(R^{24})-$  group, oxygen atom, sulfur atom or selenium atom,  $R^{21}$  represents an aliphatic group having 10 or less carbon atoms and a water-solubilizing group,  $R^{22}$ ,  $R^{23}$  and  $R^{24}$  each 5 independently represent an aliphatic group, an aryl group or a heterocyclic group, where at least two of  $R^{22}$ ,  $R^{23}$  and  $R^{24}$  have a water-solubilizing group,  $V^{21}$  and  $V^{22}$  each independently represent hydrogen atom, an alkyl group, an alkoxy group or an aryl group, or  $V^{21}$  and  $V^{22}$  bind together to represent a group 10 forming a condensed ring with the azole ring,  $L^{21}$  and  $L^{22}$  each independently represent a substituted or unsubstituted methine group,  $M^{21}$  represents an ion required to offset the total intramolecular charge, and  $n^{21}$  represents the number of the ion required to offset the total intramolecular charge;

15

Formula IV



wherein, in the formula (IV),  $Y^1$ ,  $Y^2$  and  $Y^3$  each independently represent  $-N(R^5)-$ , oxygen atom, sulfur atom, selenium atom or tellurium atom,  $Z^1$  represents a nonmetallic atom group required to form a 5- or 6-membered nitrogen-containing heterocyclic group, which may form a condensed ring,  $R^1$  represents an aliphatic group having 8 or less carbon atoms and a water- 20

solubilizing group,  $R^2$ ,  $R^3$ ,  $R^4$  and  $R^5$  each independently represent an aliphatic group, an aryl group or a heterocyclic group, where at least two of  $R^2$ ,  $R^3$ ,  $R^4$  and  $R^5$  have a water-solubilizing group,  $W$  represents oxygen atom, sulfur atom or  $=C(E^1)(E^2)$  where  $E^1$  and  $E^2$  each independently represent an electron-withdrawing group, and  $E^1$  and  $E^2$  may bind together to form a keto ring or an acidic heterocyclic ring,  $L^1$  and  $L^2$  each independently represent a substituted or unsubstituted methine group,  $l$  represents 0 or 1,  $M^1$  represents an ion required to offset the total intramolecular charge,  $n^1$  represents the number of the ion required to offset the total intramolecular charge.

Preferably, the silver halide photographic light-sensitive material contains at least one kind of hydrazine derivative in the silver halide emulsion layer and/or the hydrophilic colloid layer, at least one side of the silver halide photographic light-sensitive material has a conductivity represented by a surface resistivity of  $1 \times 10^{12} \Omega$  or less, and the silver halide photographic light-sensitive material contains a composite latex comprising inorganic particles and an organic polymer in the emulsion layer. Preferably, the silver halide photographic light-sensitive material is subjected to development in the presence of a benzotriazole compound, the hydrazine derivative is contained in an amount of  $1.0 \times 10^{-4}$  mol/mol Ag or more, the dye for spectral sensitization is dissolved in water at a concentration of 0.05 weight % or more, and the silver halide photographic light-sensitive material has a gelatin layer between the emulsion

layer and the support. Furthermore, it is also preferred that coated silver amount in the silver halide photographic light-sensitive material is 3.0 g/m<sup>2</sup> or less.

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#### BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 shows absorption spectra for emulsion layer side and back layer side of a silver halide photographic light-sensitive material according to an embodiment of the present invention. The longitudinal axis represents absorbance (graduated in 0.1), and the transverse axis represents wavelength of from 350 nm to 900 nm. The solid line represents the absorption spectrum of the emulsion layer side, and the broken line represents the absorption spectrum of the back layer side.

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#### BEST MODE FOR CARRYING OUT THE INVENTION

The silver halide photographic light-sensitive material of the present invention will be explained in detail hereafter. In the present specification, ranges indicated with "to" mean ranges including the numerical values before and after "to" as the minimum and maximum values, respectively.

The silver halide photographic light-sensitive material of the present invention is partly characterized in that it contains a silver halide emulsion spectrally sensitized with at least one kind of dye selected from those represented by any one of the formulas (I) to (IV).

The formula (I) will be explained in detail. In the

formula (I),  $Y^1$  and  $Y^2$  each independently represent a nonmetallic atom group required to form benzothiazole ring, benzoselenazole ring, naphthothiazole ring, naphthoselenazole ring or quinoline ring, and these heterocyclic rings may be 5 substituted with a lower alkyl group, an alkoxy group, an aryl group, hydroxyl group, an alkoxy carbonyl group or a halogen atom.  $R^{31}$  and  $R^{32}$  each independently represent a lower alkyl group or an alkyl group having sulfo group or carboxyl group.  $R^{33}$  represents methyl group, ethyl group or propyl group.  $X^1$  10 represents an anion.  $n^1$  and  $n^2$  each independently represent 0 or 1.  $m^1$  represents 1 or 2, and  $m^1$  is 0 when an intramolecular salt is formed.

Hereafter, the formula (I) will be explained in more detail. In the formula (I),  $Y^1$  and  $Y^2$  each independently represent a nonmetallic atom group required to form benzothiazole ring, benzoselenazole ring, naphthothiazole ring, naphthoselenazole ring or quinoline ring. These heterocyclic rings may be substituted with a lower alkyl group (an alkyl group having 1 to 6 carbon atoms, preferably an alkyl group having 1 to 4 carbon atoms, e.g., methyl group, ethyl group etc.), an alkoxy group (e.g., methoxy group, ethoxy group etc.), hydroxyl group, an aryl group (e.g., phenyl group), an alkoxy carbonyl group (e.g., methoxycarbonyl group), a halogen atom (e.g., chlorine atom, bromine atom etc.) or the like.  $R^{31}$  20 and  $R^{32}$  represent a lower alkyl group (an alkyl group having 1 to 6 carbon atoms, preferably an alkyl group having 1 to 4 carbon atoms, e.g., methyl group, ethyl group, propyl group, 25 etc.).

butyl group etc.), an alkyl group having sulfo group (e.g.,  $\beta$ -sulfoethyl group,  $\gamma$ -sulfopropyl group,  $\gamma$ -sulfobutyl group,  $\delta$ -sulfobutyl group, a sulfoalkoxyalkyl group [e.g., sulfoethoxyethyl group, sulfopropoxyethyl group etc.]), or an

5 alkyl group having carboxyl group (e.g.,  $\beta$ -carboxylethyl group,  $\gamma$ -carboxypropyl group,  $\gamma$ -carboxybutyl group,  $\delta$ -carboxybutyl group).  $R^{33}$  represents methyl group, ethyl group or propyl group.

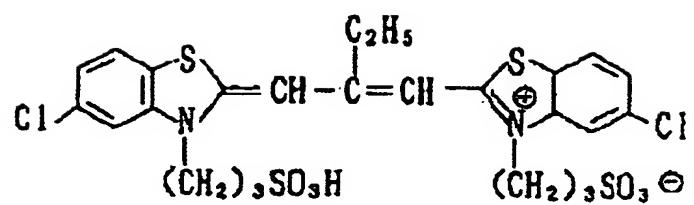
$X^1$  represents an anion usually used for cyanine dyes (e.g., a halogen ion, benzenesulfonate ion, p-toluenesulfonate ion etc.).

10  $m^1$  represents 1 or 0, and  $m^1$  is 0 when an intramolecular salt is formed.

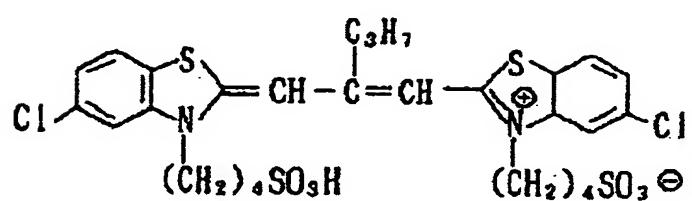
Specific examples of the compounds represented by the formula (I) are listed below. However, the compounds represented by the formula (I) that can be used for the present

15 invention are not limited to the following compounds.

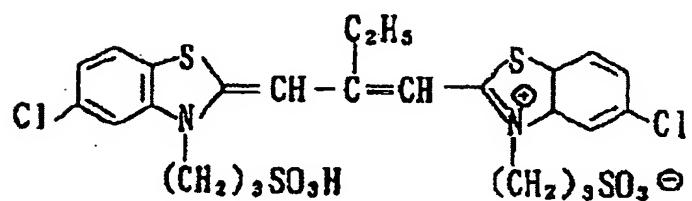
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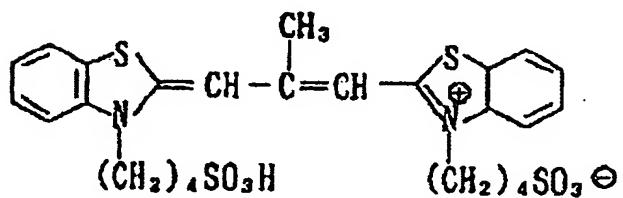
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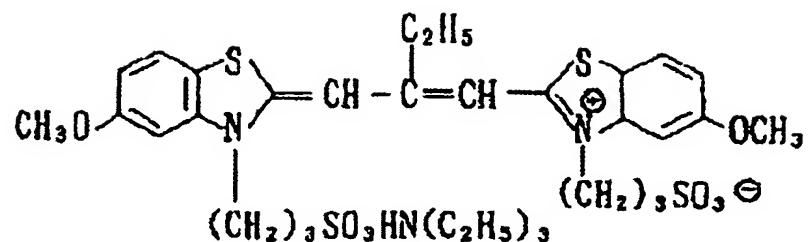
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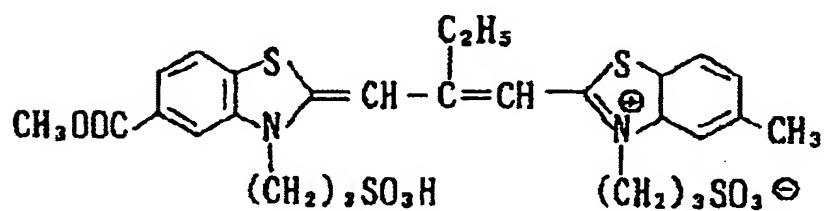
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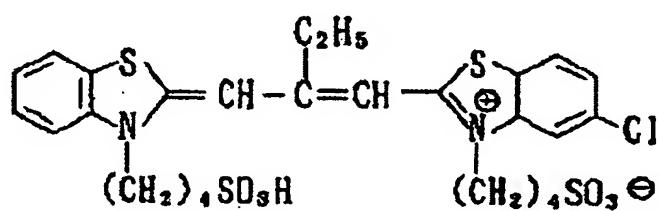
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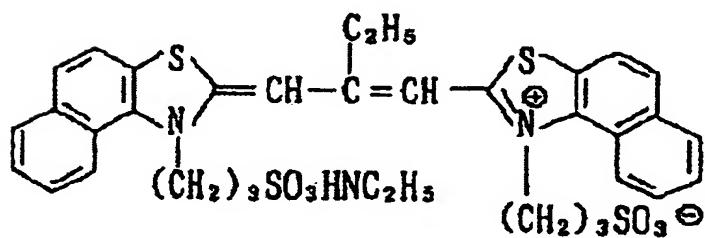
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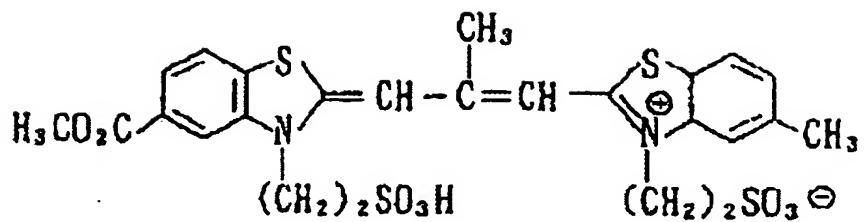
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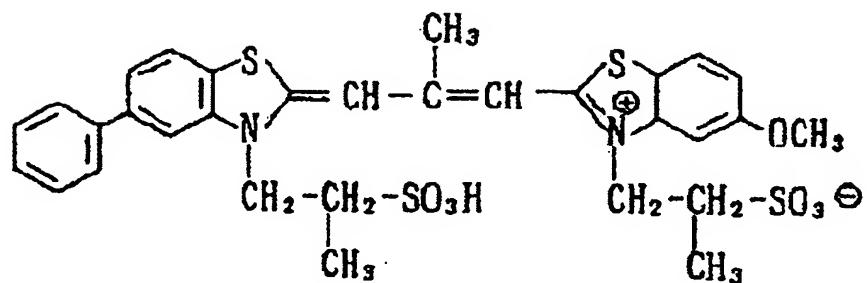
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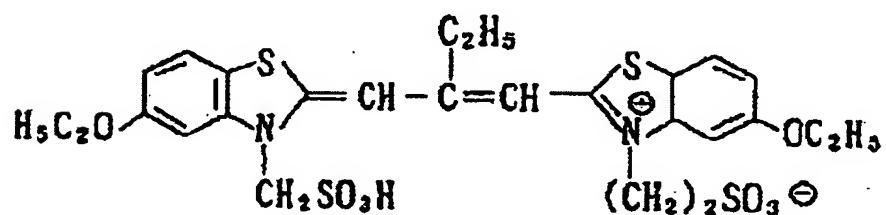
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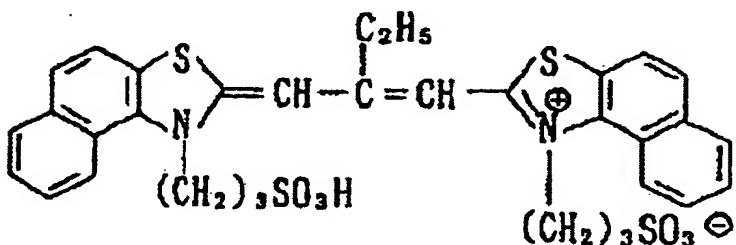
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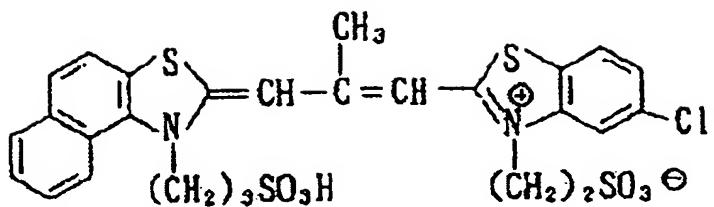
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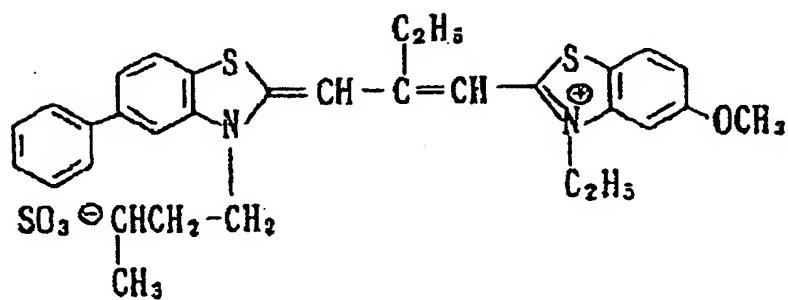
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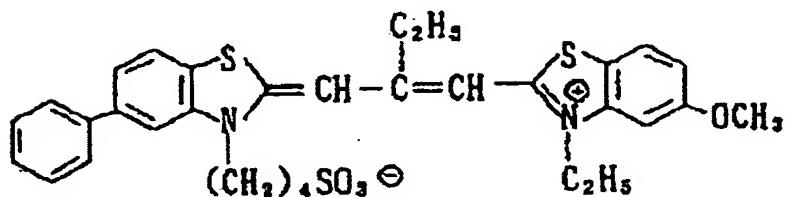
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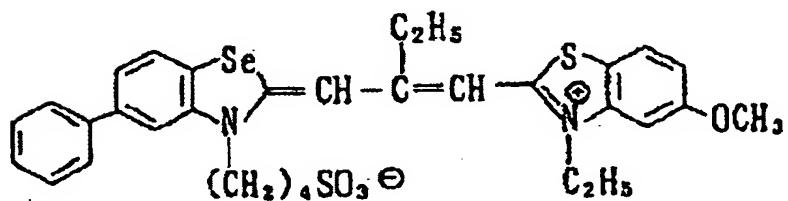
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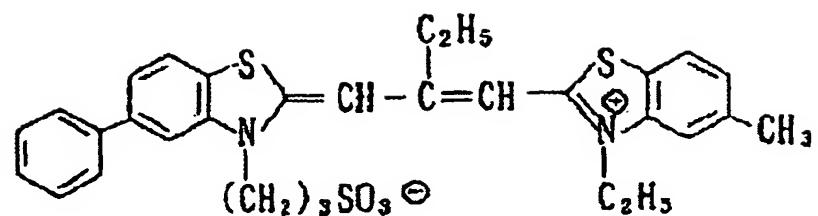
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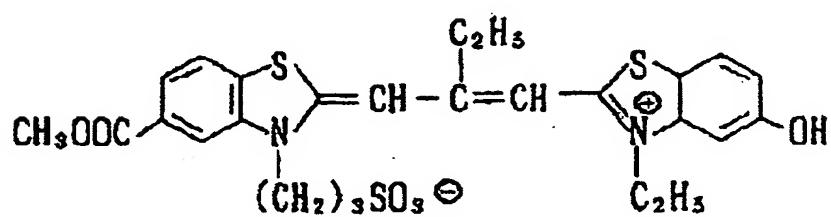
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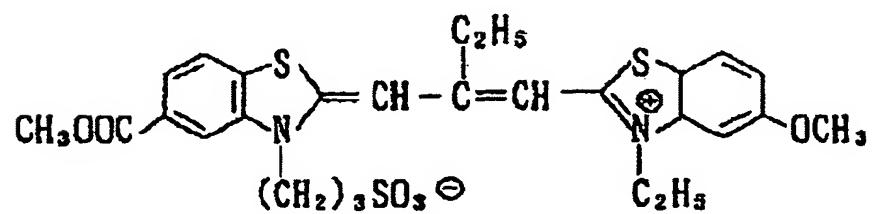
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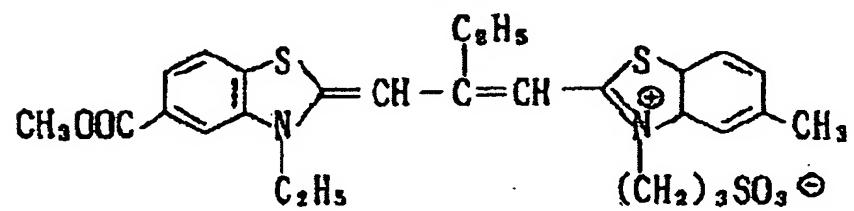
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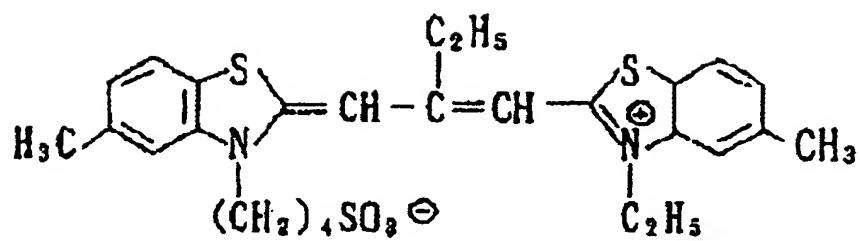
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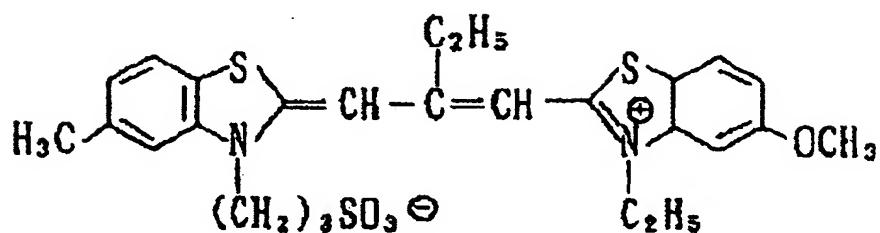
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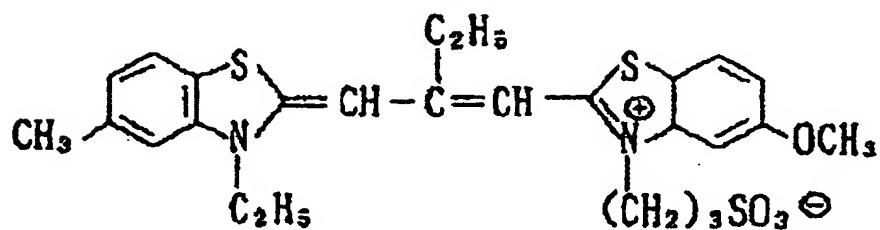
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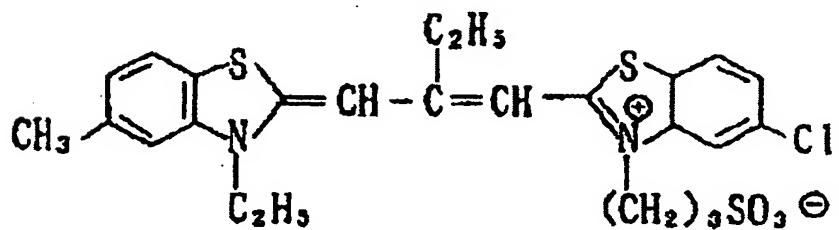
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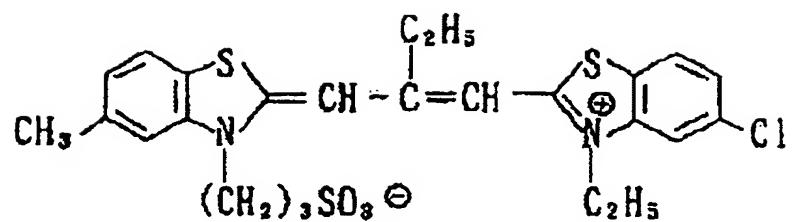
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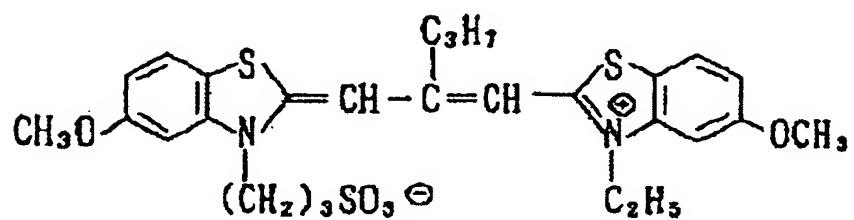
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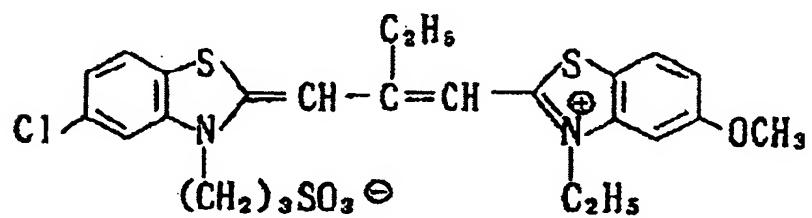
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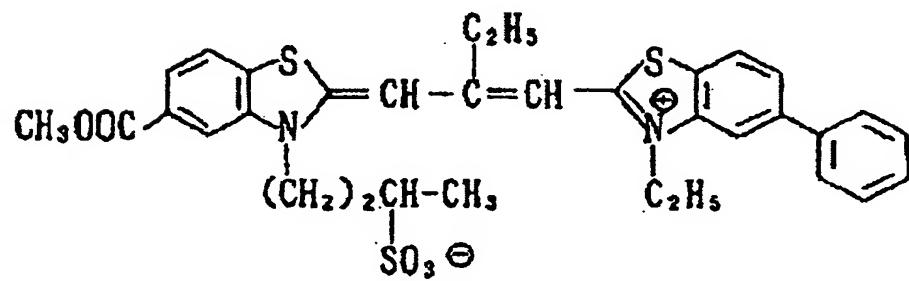
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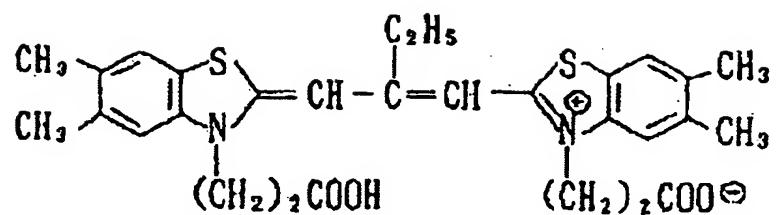
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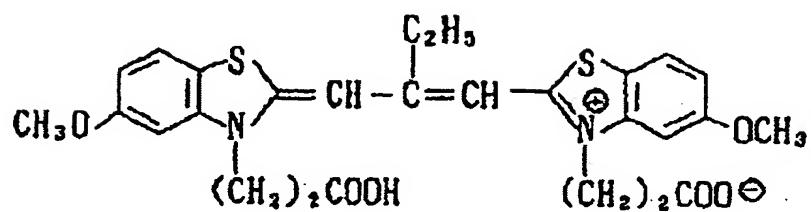
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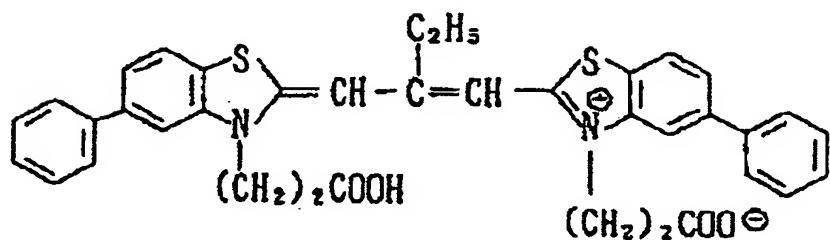
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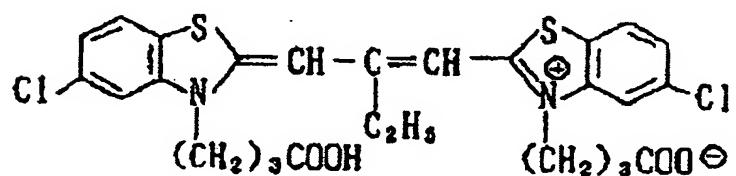
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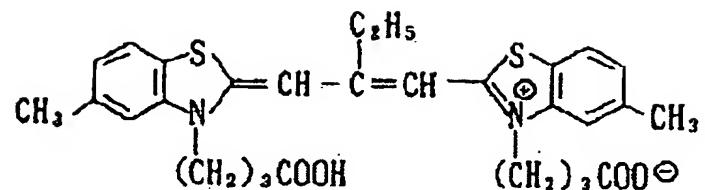
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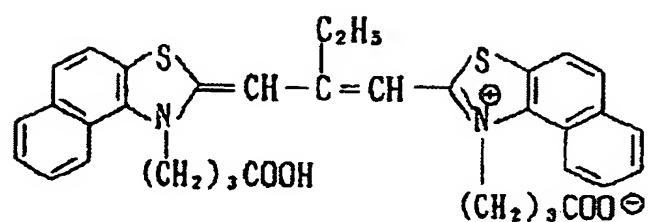
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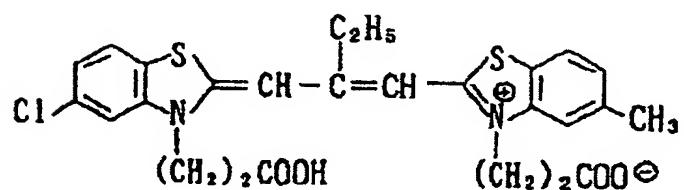
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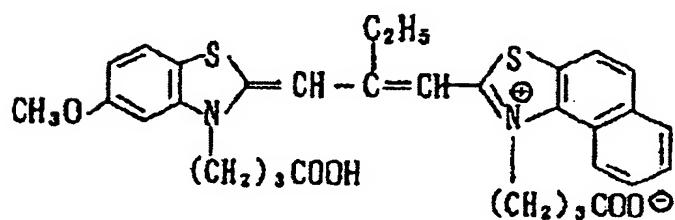
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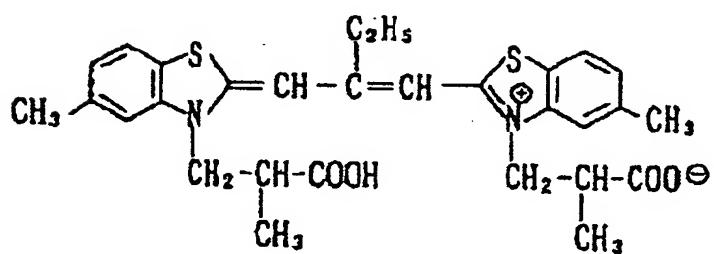
I-35



I-36



I-37



Hereafter, the formula (II) will be explained in detail.

In the formula (II),  $Z^1$  and  $Z^2$  each independently represent an atomic group required to complete a heterocyclic ring,  $Z^3$  represents an atomic group required to form a nitrogen-containing heterocyclic ring, which has a substituent ( $R^{43}$ ) on a nitrogen atom in  $Z^3$ .  $R^{41}$  and  $R^{42}$  each independently represent an alkyl group, an alkenyl group, an aralkyl group or an aryl group.  $R^{43}$  represents a substituent having the same meaning as that of  $R^{41}$  or  $R^{42}$ , a substituted amino group, amido group, imino group, an alkoxy group or a heterocyclic group. At least one of  $R^{41}$ ,  $R^{42}$  and  $R^{43}$  represents a water-soluble group.

$L^{11}$  to  $L^{19}$  each independently represent a methine group,  $m$  and  $n$  each independently represent 0, 1 or 2, and  $l$  and  $p$  each independently represent 0 or 1.  $X$  represents a counter ion.

Examples of the heterocyclic ring constituted by  $Z^1$  or  $Z^2$  in the aforementioned formula (II) include, for example, rings of oxazoline, oxazole, benzoxazole, benzisoxazole, naphthoxazole, thiazoline, thiazole, benzothiazole, naphthothiazole, selenazoline, selenazole, benzoselenazole, naphthoselenazole, tellurazole, benzotellurazole, pyridine, quinoline, benzoquinoline, indolenine, benzoindolenine, benzimidazole, pyrroline and so forth.

These heterocyclic rings may be substituted with a known substituent such as an alkyl group, an alkoxy group, an aryl group, hydroxy group, carboxy group, an alkoxy carbonyl group and a halogen group.

Preferred examples of the 5- or 6- membered nitrogen-

containing heterocyclic ring formed by  $Z^3$  are those formed by removing oxo group or thioxo group from hydantoin, 2- or 4-thiohydantoin, 2-oxazolin-5-one, 2-thioxazoline-2,4-dione, thiazolidine-2,4-dione, rhodanine, thiazolidine-2,4-dithione,

5 barbituric acid and 2-thiobarbituric acid, more preferred are those formed by removing oxo group or thioxo group from hydantoin, 2- or 4-thiohydantoin, 2-oxazolin-5-one, rhodanine, barbituric acid and 2-thiobarbituric acid, and the most preferred are those formed by removing oxo group or thioxo

10 group from 2- or 4-thiohydantoin, 2-oxazolin-5-one and rhodanine.

The alkyl group represented by  $R^{41}$ ,  $R^{42}$  or  $R^{43}$  in the aforementioned formula (II) is preferably an alkyl group having 1 to 6 carbon atoms, and it may be a linear, branched or cyclic

15 alkyl group. The alkyl group may have a substituent such as methyl group, ethyl group, isopropyl group, cyclohexyl group, allyl group, trifluoromethyl group,  $\beta$ -hydroxyethyl group, acetoxyethyl group, carboxymethyl group, ethoxycarbonylmethyl group,  $\beta$ -methoxyethyl group,  $\gamma$ -methoxypropyl group,  $\beta$ -benzoyloxyethyl group,  $\gamma$ -sulforpropyl group and  $\delta$ -sulfonyl group.

20

Examples of the alkenyl group include allyl group etc., examples of the aralkyl group include benzyl group, phenethyl group, sulfobenzyl group etc., and examples of the aryl group

25 include phenyl group, tolyl group, chlorophenyl group, sulfophenyl group etc.

Examples of the group binding to a nitrogen atom or

oxygen atom as R<sup>43</sup> include, for example, an alkyl group, an alkenyl group, an aralkyl group, an aryl group, an acyl group, an alkylsulfonyl group, a heterocyclic ring group etc., which may be bound via a double bond and may form a ring. Examples of 5 R<sup>43</sup> include, for example, dimethylamino group, diethylamino group, N-methylanilino group, 1-piperidino group, 1-morpholino group, N-methyl-2-pyridinoamino group, benzylideneimino group, dibenzylamino group, N-acetylmethylamino group, benzylamino group, acetamino group, N-methylsulfonylamino group, N- 10 methylureido group, 3-methylbenzothiazolideneimino group and so forth, and examples of the alkoxy group include methoxy group, ethoxy group and so forth.

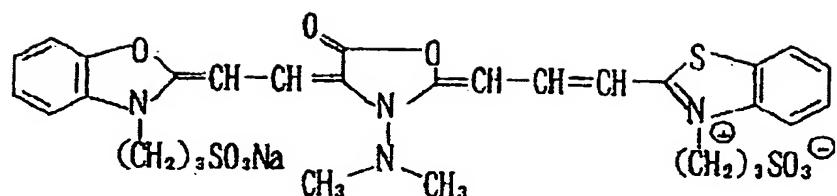
However, at least one of R<sup>41</sup>, R<sup>42</sup> and R<sup>43</sup> has at least one water-soluble group. The water-soluble group referred to herein 15 means a substituent containing sulfo group (or a salt thereof), carboxyl group (or a salt thereof), hydroxyl group, mercapto group, amino group, ammonio group, sulfonamido group, an acylsulfamoyl group, sulfonylsulfamoyl group, an active methine group or a group containing any of these groups, preferably 20 sulfo group (or a salt thereof), carboxyl group (or a salt thereof), hydroxyl group, amino group or the like.

As for the counter ion represented by X, when an intramolecular salt can be formed, X does not exist, when two acidic groups (sulfo, sulfate, carboxyl etc.) exist in the 25 molecule, it represents a cation such as those of an alkali metal atom, organic ammonium etc. L<sup>11</sup> to L<sup>19</sup> each independently represent a methine group, which may be substituted with an

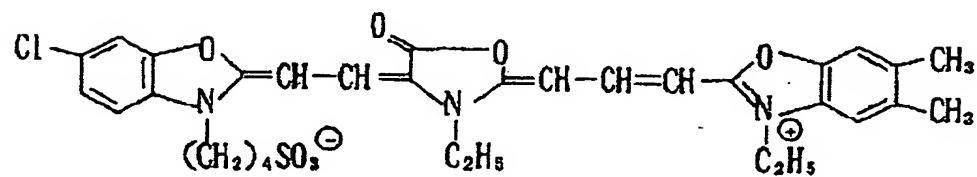
alkyl group, an aryl group, an alkoxy group or the like.

Specific examples of the compounds represented by the formula (II) are listed below. However, the compounds that can be used for the present invention are not limited to these.

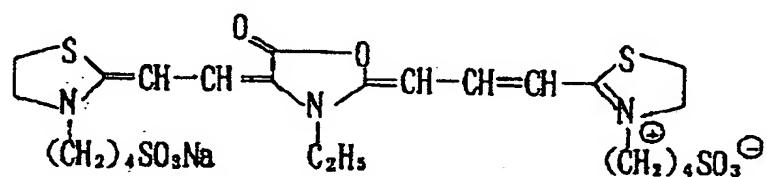
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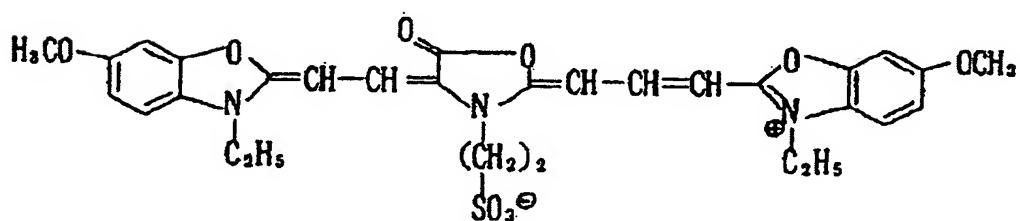
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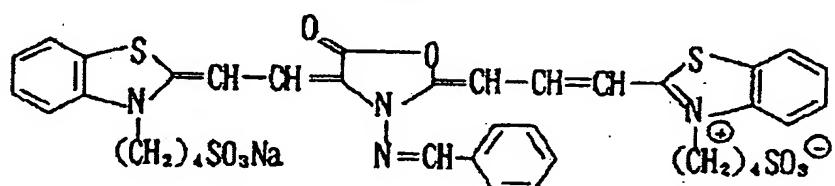
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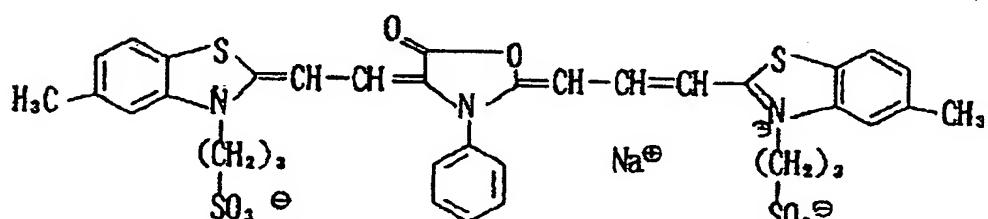
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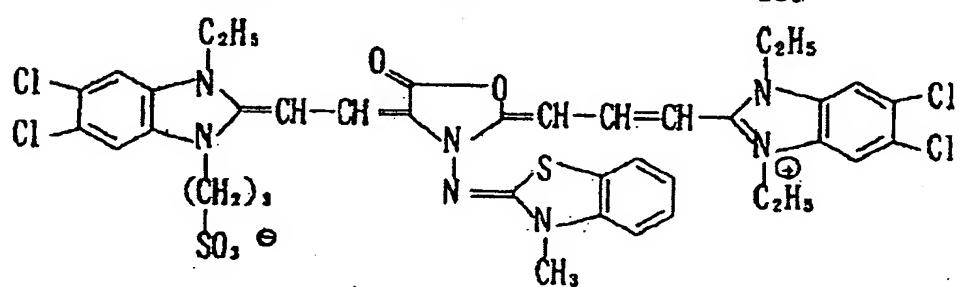
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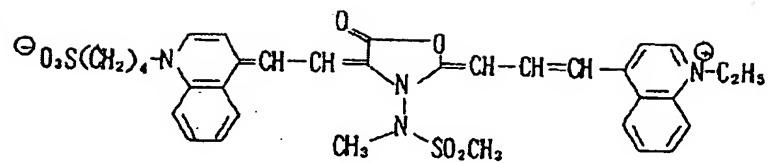
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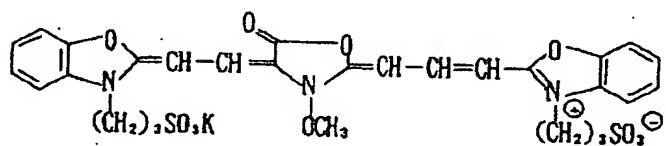
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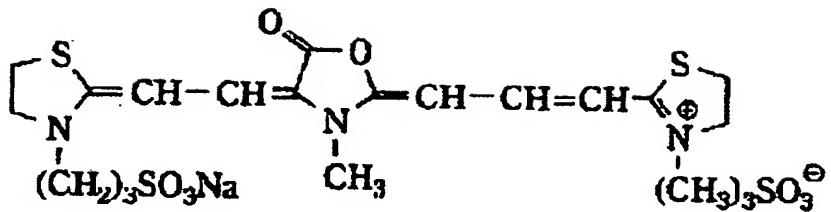
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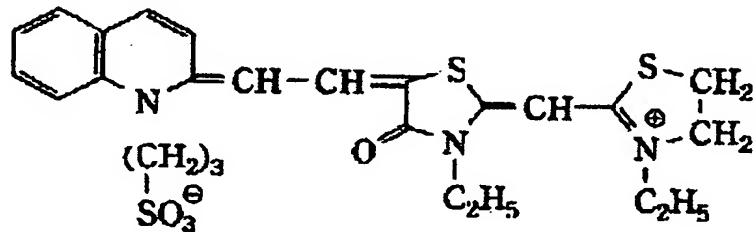
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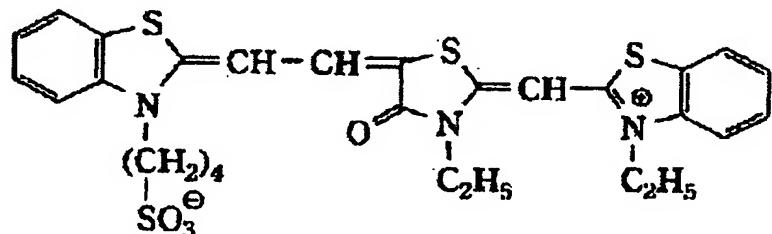
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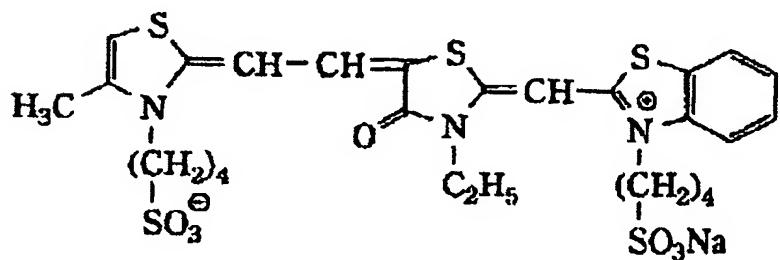
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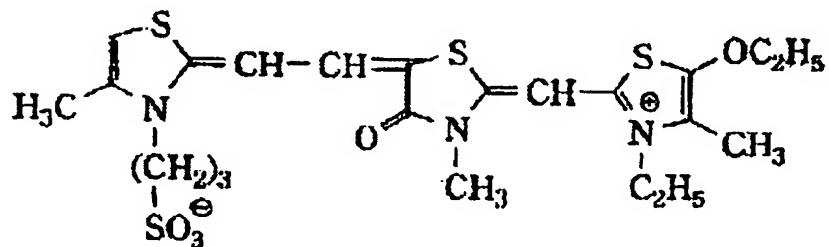
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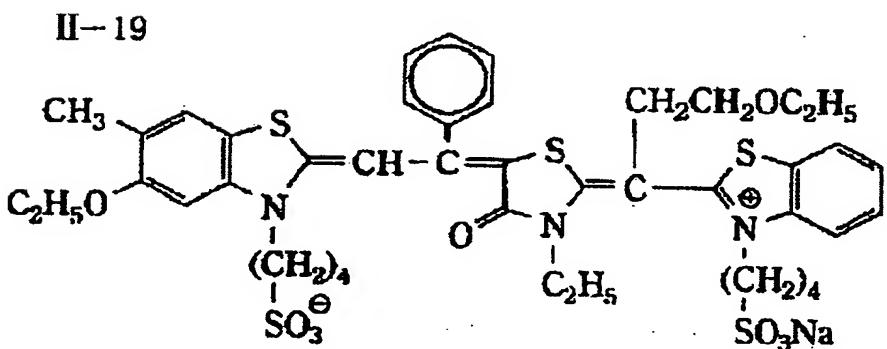
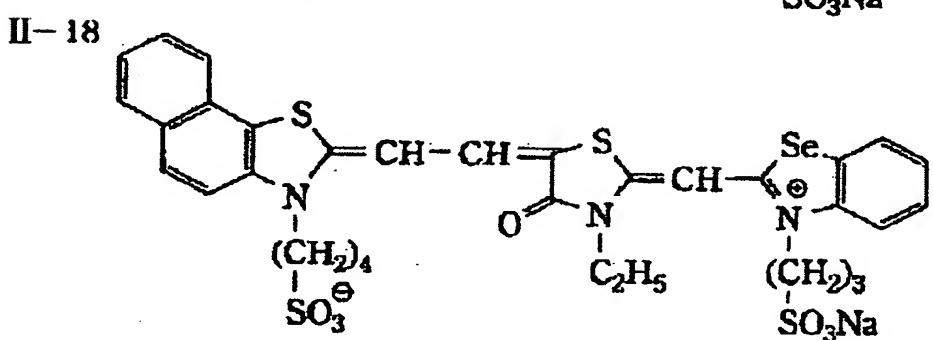
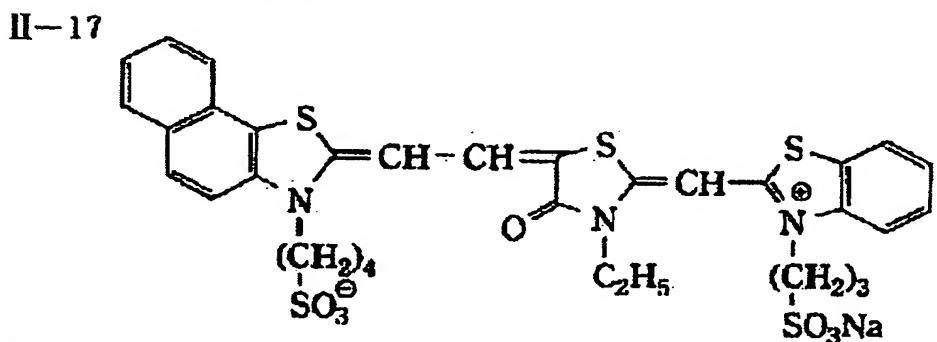
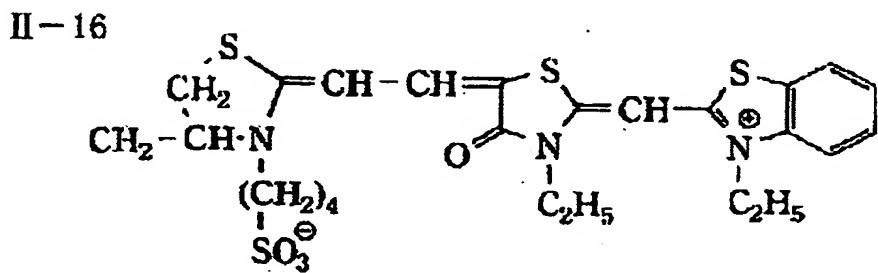
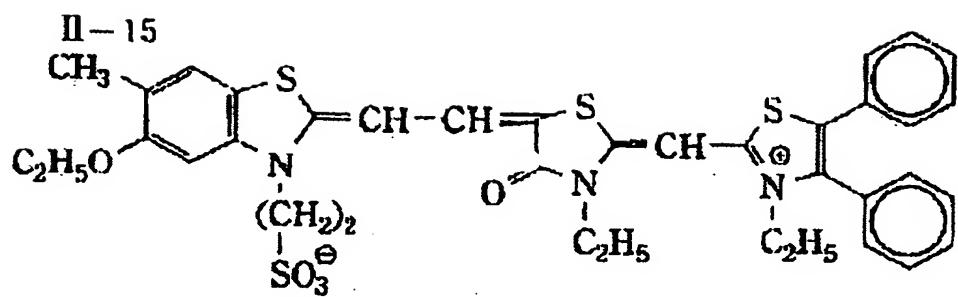


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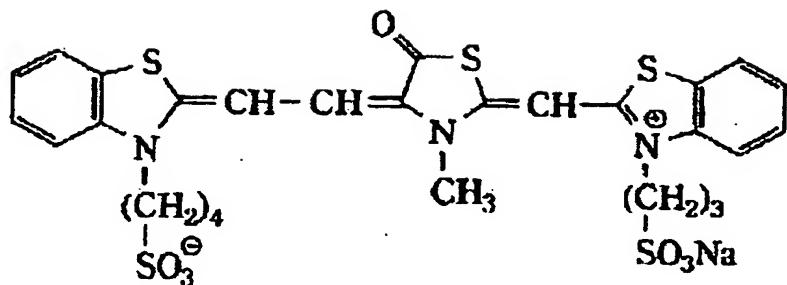


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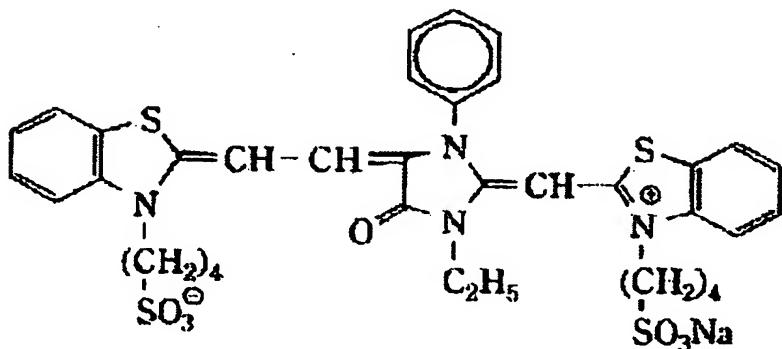




II - 20



II - 21



The compounds represented by the aforementioned formula

(I) or (II) can be synthesized by the methods described in F.M.

Hamer, "Heterocyclic Compounds - Cyanine Dyes and Related

5 Compounds" (John Wiley & Sons, New York, London, published on 1964; D.M. Sturmer, "Heterocyclic Compounds ---Special Topics in Heterocyclic Chemistry---", Chapter 18, Section 14, pages 482-515, John Wiley & Sons, New York, London, published on 1977; "Rodd's Chemistry of Carbon Compounds" 2nd Ed., Vol. IV, 10 Part B, published on 1977, Chapter 15, pages 369-422 and 2nd Ed., vol. IV, Part B, published on 1985, Chapter 15, pages 267-296, published by Elsevier Science Publishing Company Inc., New York, etc.

Hereafter, the dyes represented by the formula (III) will

be explained in detail. In the formula (III),  $Y^{21}$ ,  $Y^{22}$  and  $Y^{23}$  each independently represent a  $-N(R^{24})-$  group, oxygen atom, sulfur atom or selenium atom.

Examples of the water-solubilizing group substituting on  $R^{21}$ ,  $R^{22}$  or  $R^{23}$  include, for example, an acidic group such as sulfo group, carboxyl group, phosphono group, sulfato group and sulfino group.

Examples of the aliphatic group represented by  $R^{21}$ ,  $R^{22}$  or  $R^{23}$  include, for example, a linear or branched alkyl group having 1 to 10 carbon atoms (e.g., methyl group, ethyl group, n-propyl group, n-pentyl group, isobutyl group etc.), an alkenyl groups having 3 to 10 carbon atoms (e.g., 3-butenyl group, 2-propenyl group etc.) and an aralkyl group having 3 to 10 carbon atoms (e.g., benzyl group, phenethyl group etc.).

Examples of the aryl group represented by  $R^{22}$ ,  $R^{23}$  or  $R^{24}$  include, for example, phenyl group, and examples of the heterocyclic group represented by  $R^{22}$ ,  $R^{23}$  or  $R^{24}$  include, for example, a pyridyl group (2-, 4-), a furyl group (2-), a thienyl group (2-), a sulfolanyl group, a tetrahydrofuryl group, a piperidinyl group and so forth.

Each of the groups of  $R^{21}$ ,  $R^{22}$  and  $R^{23}$  may be substituted with a substituent such as a halogen atom (e.g., fluorine atom, chlorine atom, bromine atom etc.), an alkoxy group (e.g., methoxy group, ethoxy group etc.), an aryloxy group (e.g., phenoxy group, p-tolyloxy group etc.), cyano group, a carbamoyl groups (e.g., carbamoyl group, N-methylcarbamoyl group, N,N-tetramethylenecarbamoyl group etc.), a sulfamoyl group (e.g.,

sulfamoyl group, N,N-3-oxapentamethyleneaminosulfonyl group etc.), methanesulfonyl group, an alkoxycarbonyl group (e.g., ethoxycarbonyl group, butoxycarbonyl group etc.), an aryl group (e.g., phenyl group, carboxyphenyl group etc.) and an acyl group (e.g., acetyl group, benzoyl group etc.).

Specific examples of the aliphatic group substituted with a water-solubilizing group include carboxymethyl, sulfoethyl group, sulfopropyl group, sulfobutyl group, sulfopentyl group, 3-sulfobutyl group, 6-sulfo-3-oxahexyl group,  $\omega$ -sulfopropoxyaminocarbonylmethyl group,  $\omega$ -sulfopropylaminocarbonylmethyl group, 3-sulfinobutyl group, 3-phosphonopropyl group, 4-sulfo-3-butenyl group, 2-carboxy-2-propenyl group,  $\alpha$ -sulfobenzyl group,  $p$ -sulfophenethyl group,  $p$ -carboxybenzyl group etc., specific examples of the aryl group substituted with a water-solubilizing group include  $p$ -sulfophenyl group,  $p$ -carboxyphenyl group etc., and specific examples of the heterocyclic group substituted with a water-solubilizing group include 4-sulfothienyl group, 5-carboxypyridyl group etc.

Examples of the alkyl group represented by  $V^{21}$  or  $V^{22}$  include a linear or branched alkyl group (e.g., methyl group, ethyl group, isopropyl group, tert-butyl group, isobutyl group, tert-pentyl group, hexyl group etc.). Examples of the alkoxy group represented by  $V^{21}$  or  $V^{22}$  include, for example, methoxy group, ethoxy group, propoxy group etc.

The aryl group represented by  $V^{21}$  or  $V^{22}$  may have a substituent at an arbitrary position, and examples include, for

example, phenyl group, p-tolyl group, p-hydroxyphenyl group, p-methoxyphenyl group etc. Examples of the condensed ring formed by V<sup>21</sup> and V<sup>22</sup> binding to each other together with the azole ring include, for example, condensed rings of benzoxazole, 4,5,6,7-5 tetrahydrobenzoxazole, naphtho[1,2-d]oxazole, naphtho[2,3-d]oxazole, benzothiazole, 4,5,6,7-tetrahydrobenzothiazole, naphtho[1,2-d]thiazole, naphtho[2,3-d]thiazole, benzoselenazole, naphtho[1,2-d]selenazole and so forth.

The aforementioned substituents represented by V<sup>21</sup> or V<sup>22</sup> and the condensed rings formed with V<sup>21</sup> or V<sup>22</sup> may have a substituent at an arbitrary position, and examples of the substituent include arbitrary groups including, for example, a halogen atom (fluorine atom, chlorine atom, bromine atom, iodine atom), trifluoromethyl group, an alkoxy group (e.g., an 10 unsubstituted alkoxy group such as methoxy group, ethoxy group and butoxy group, and a substituted alkoxy group such as 2-methoxyethoxy group and benzyloxy group), hydroxyl group, cyano group, an aryloxy group (e.g., a substituted or unsubstituted 15 aryloxy group such as phenoxy group and tolyloxy group), an aryl group (e.g., a substituted or unsubstituted aryl group such as phenyl group and p-chlorophenyl group), stilyl group, a heterocyclic group (e.g., furyl, thietyl etc.), a carbamoyl group (e.g., carbamoyl group, N-ethylcarbamoyl group etc.), a sulfamoyl group (e.g., sulfamoyl group, N,N-dimethylsulfamoyl 20 group etc.), an acylamino group (e.g., acetylamino group, propionylamino group, benzoylamino group etc.), an acyl group (e.g., acetyl group, benzoyl group etc.), an alkoxy carbonyl 25 group etc.).

group (e.g., ethoxycarbonyl group etc.), a sulfonamido group (e.g., methanesulfonylamido, benzenesulfonylamido etc.), a sulfonyl group (e.g., methanesulfonyl group, p-toluenesulfonyl group etc.), carboxyl group and so forth.

5 Examples of the group substituting on the carbon atom of the methine group represented by  $L^{21}$  or  $L^{22}$  include, for example, a lower alkyl group (an alkyl group having 1 to 6 carbon atoms, preferably an alkyl group having 1 to 4 carbon atoms, e.g., methyl group, ethyl group etc.), a phenyl group (e.g., phenyl group, carboxyphenyl group etc.), an alkoxy group (e.g., methoxy group, ethoxy group etc.), an aralkyl group (e.g., benzyl group etc.) and so forth.

10

15  $M^{21}$  represents a cation or an acid anion. Examples of the cation include proton, an organic ammonium ion (e.g., triethylammonium, triethanolammonium etc.) and an inorganic cation (e.g., those of lithium, sodium, calcium etc.), and examples of the acid anion include, for example, a halogen ion (e.g., chloride ion, bromide ion, iodide ion etc.), p-toluenesulfonate ion, perchlorate ion, 4-fluoroboron ion etc.

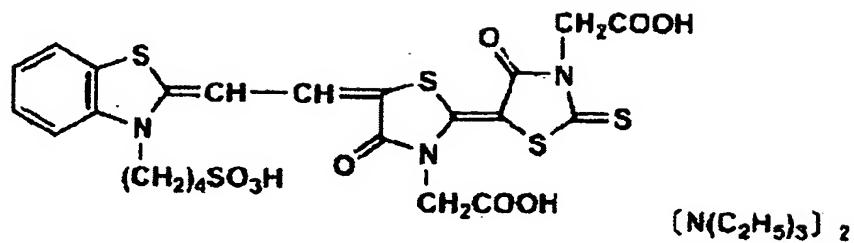
20 When an intramolecular salt is formed, and the total intramolecular charge is offset,  $n^{21}$  is 0.

In the formula (III), it is preferred that  $R^{21}$  is an alkyl group substituted with sulfo group, and at least two of  $R^{22}$ ,  $R^{23}$  and  $R^{24}$  represent carboxymethyl.

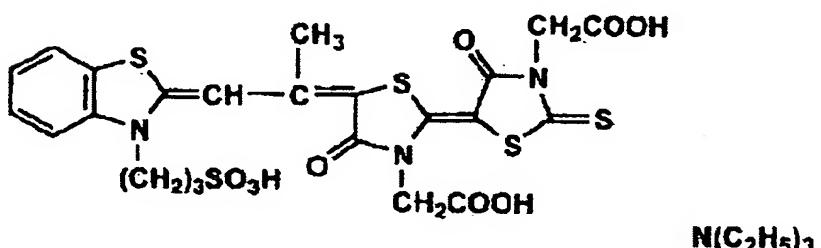
25 Specific examples of the sensitizing dyes represented by the formula (III) will be listed below. However, the compounds that can be used for the present invention are not limited to

these compounds.

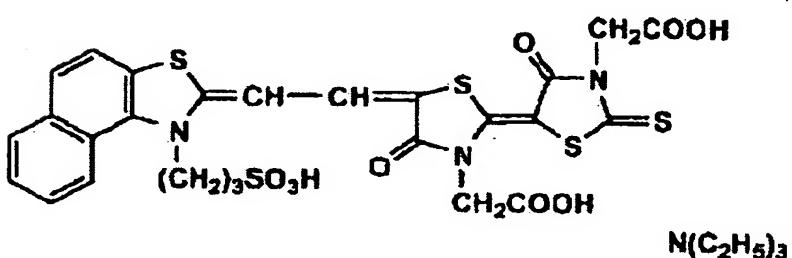
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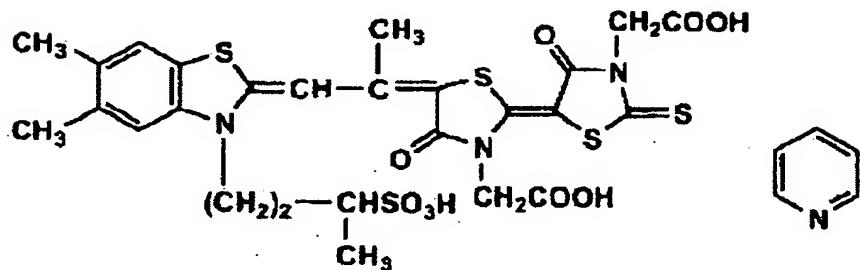
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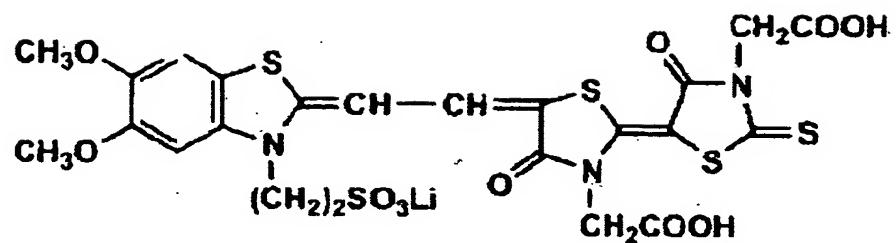
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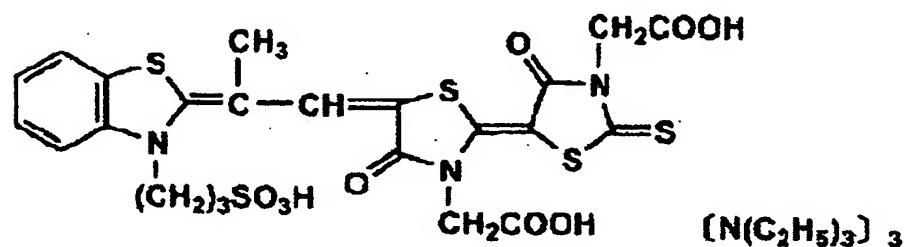
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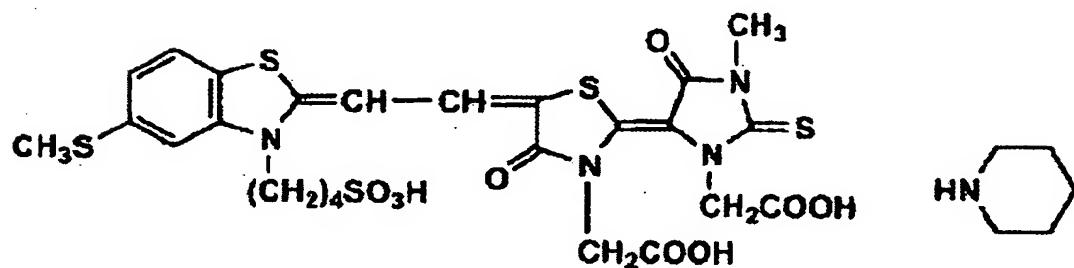
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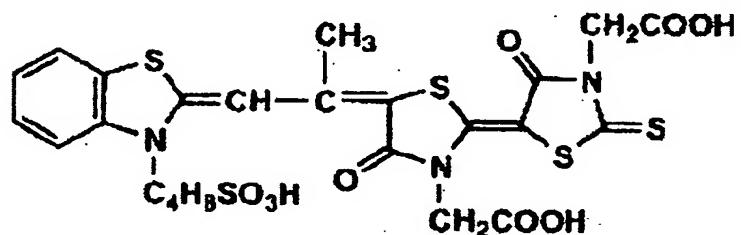
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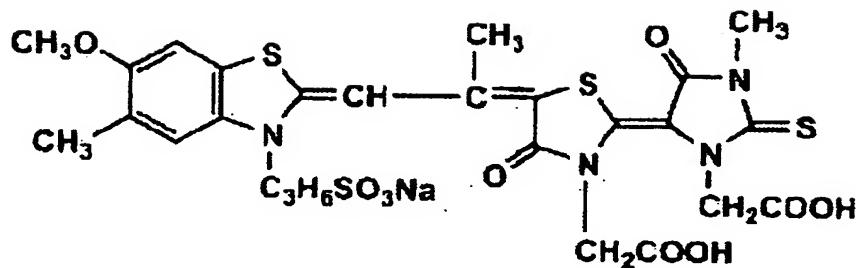
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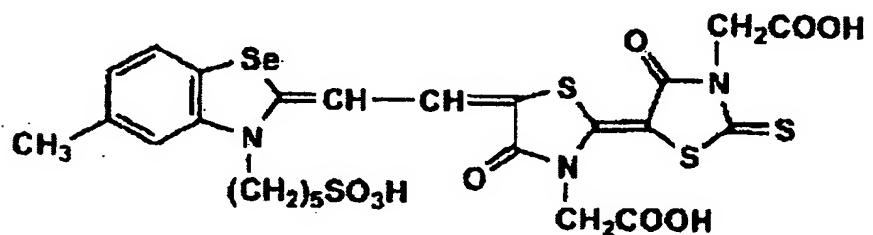
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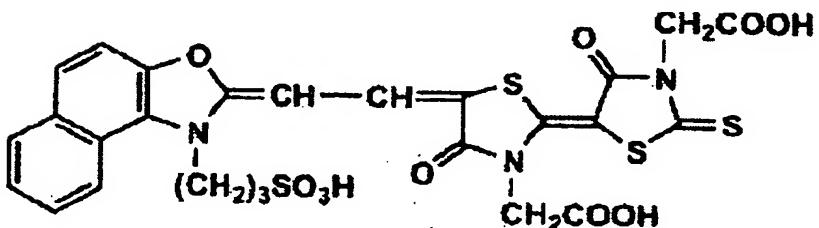
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III-10

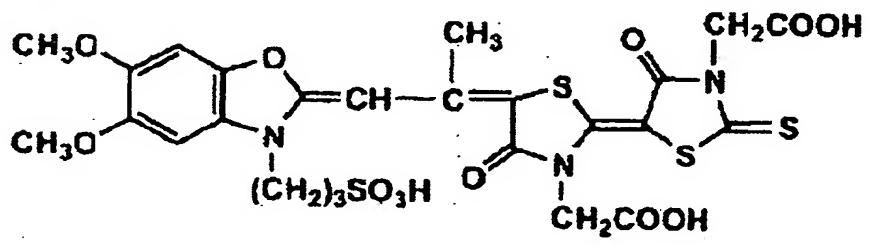


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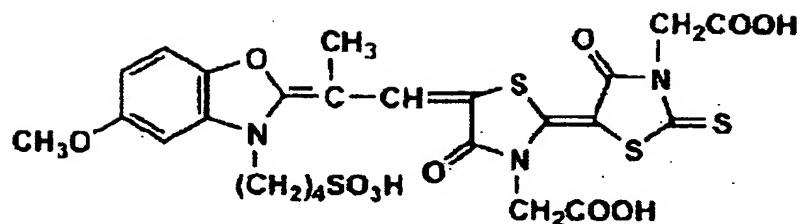
$N(C_2H_5)_3$

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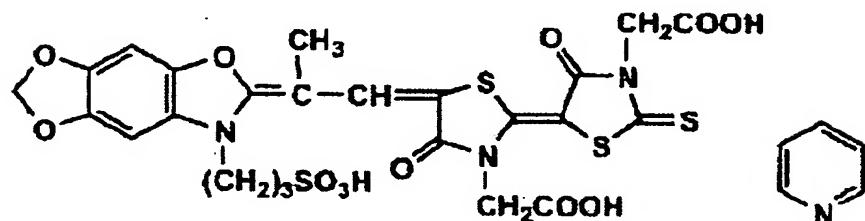


$N(C_2H_5)_3$

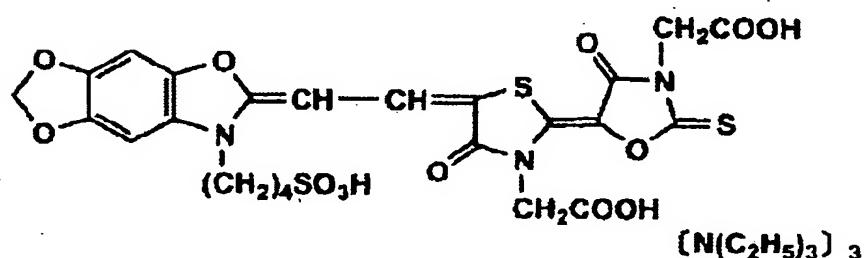
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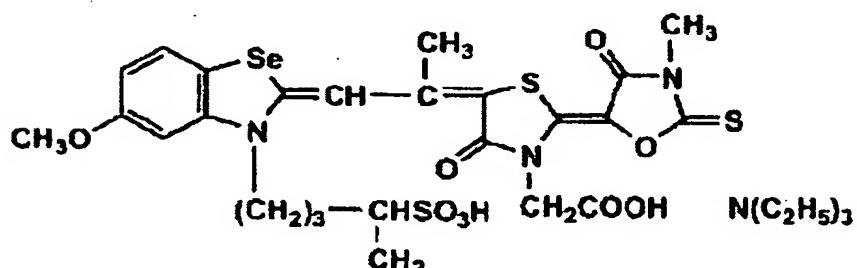
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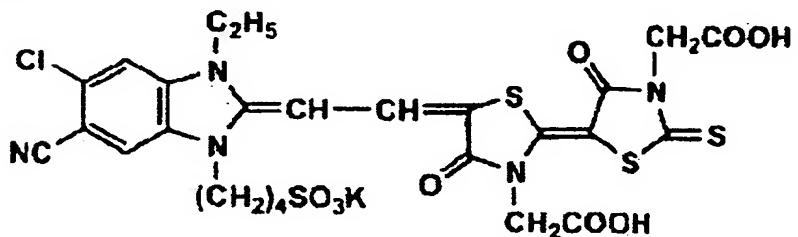
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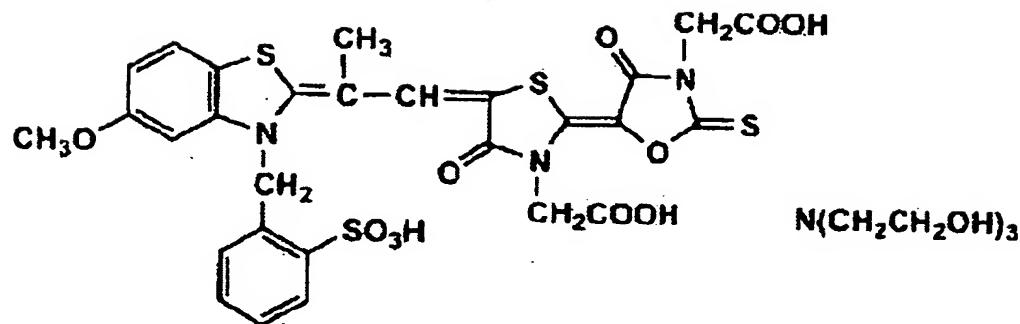
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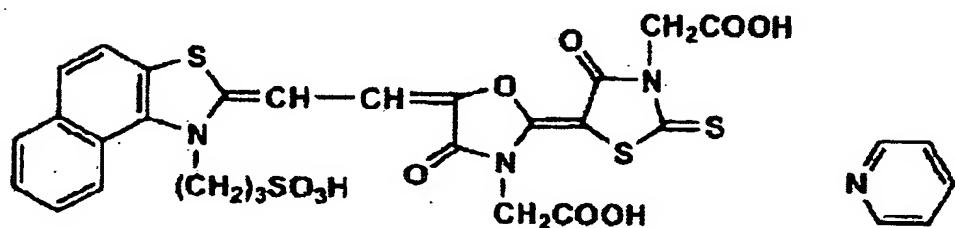
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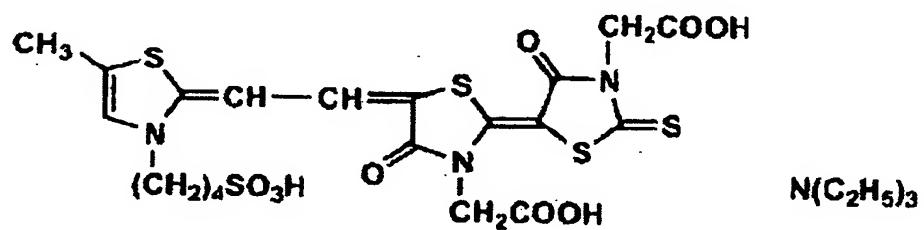
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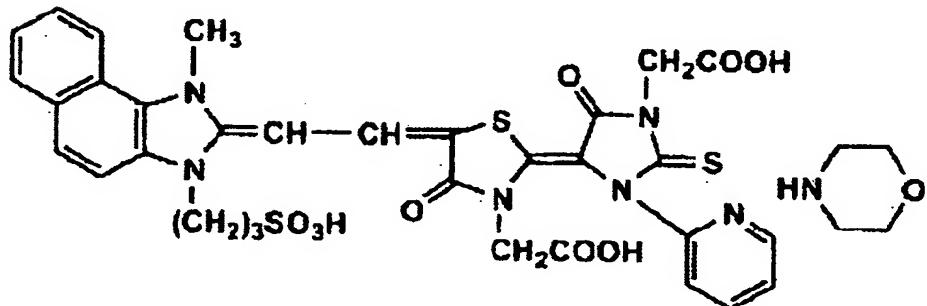
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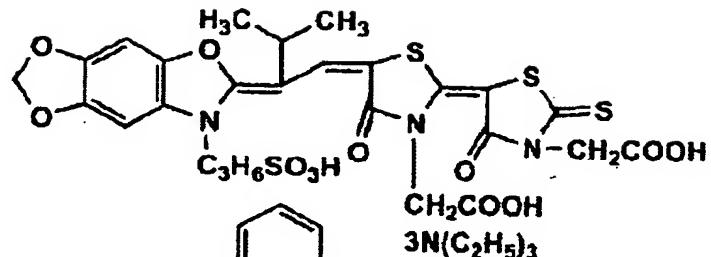
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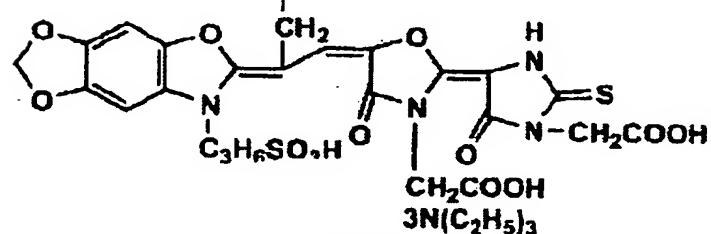
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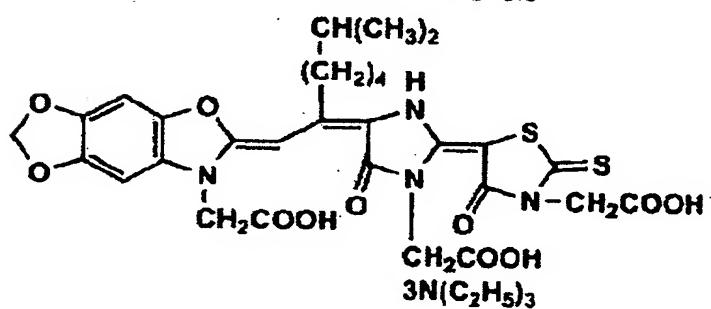
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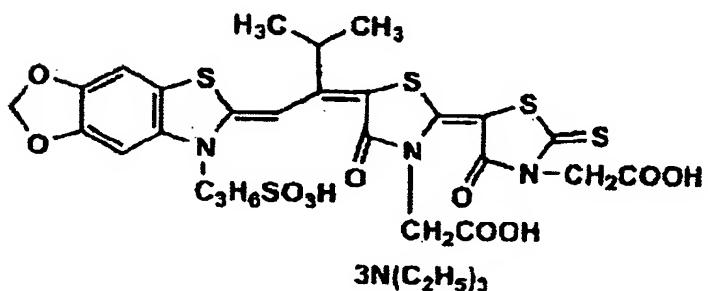
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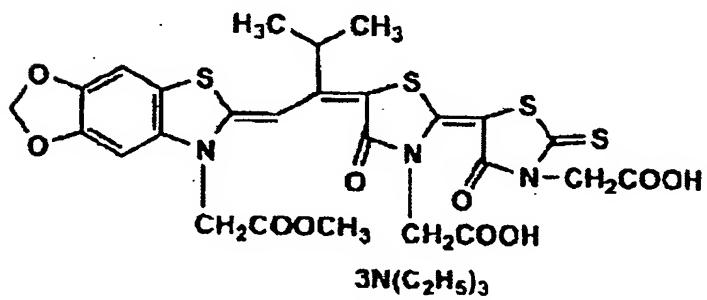
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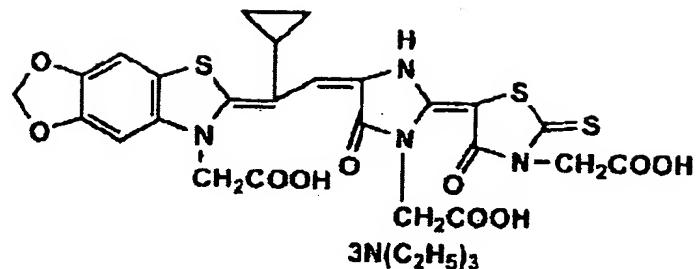
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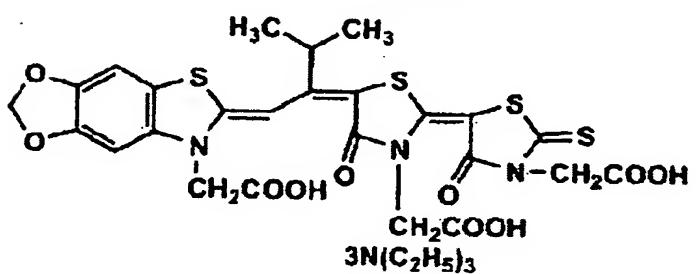
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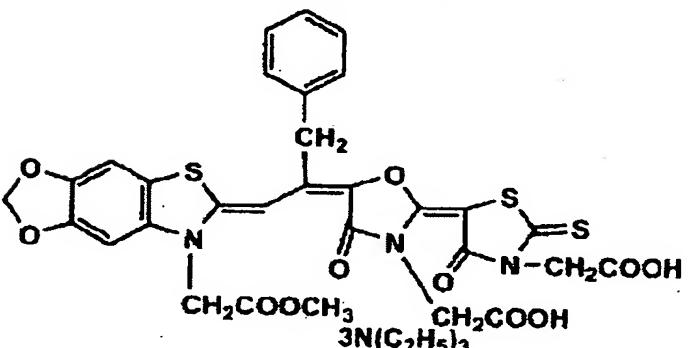
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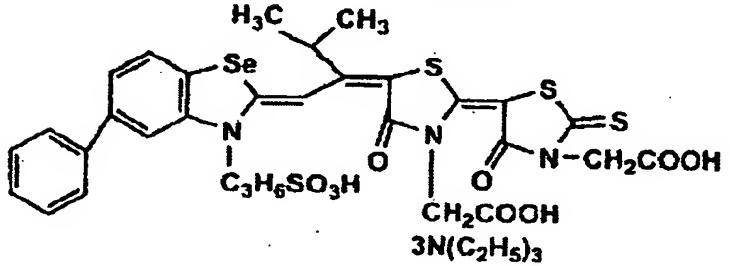
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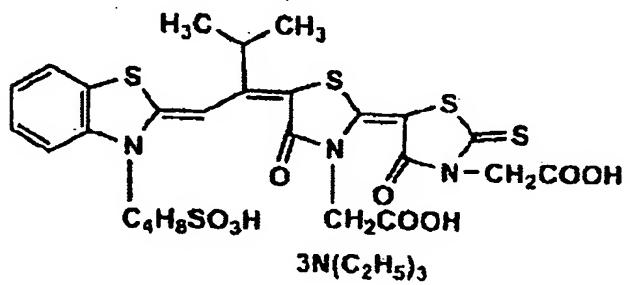
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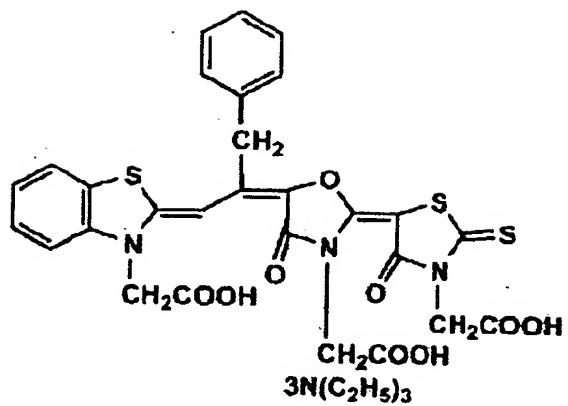
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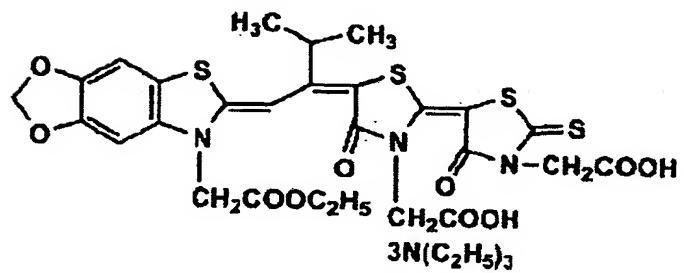
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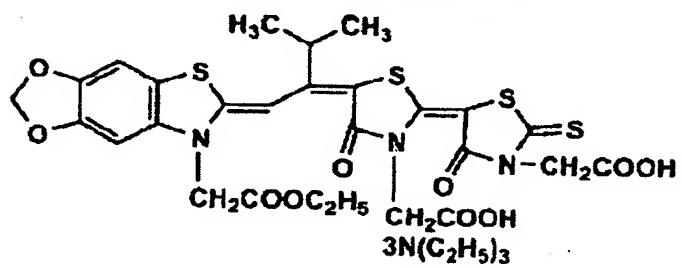
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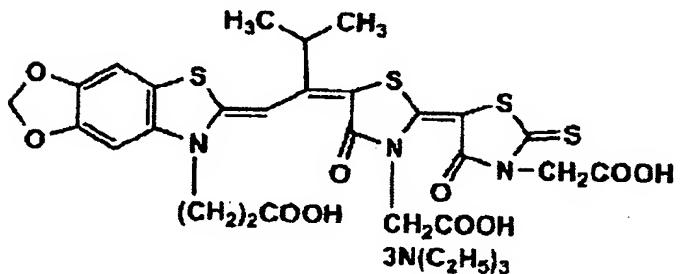
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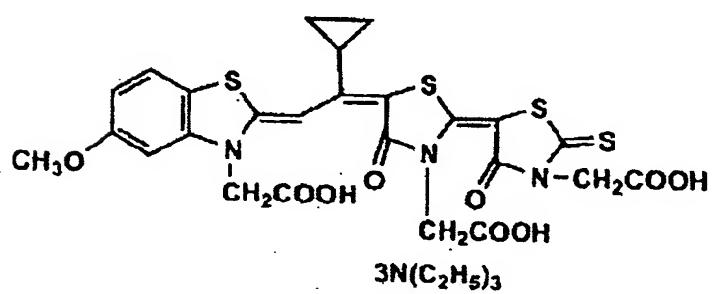
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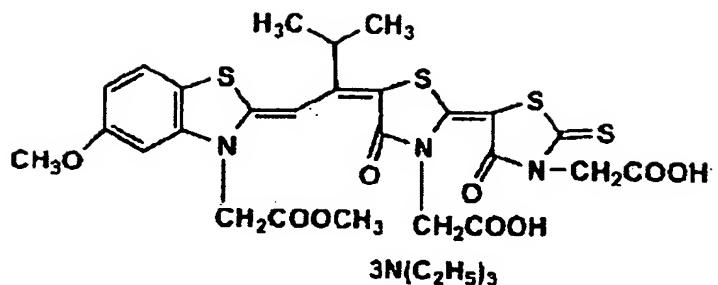
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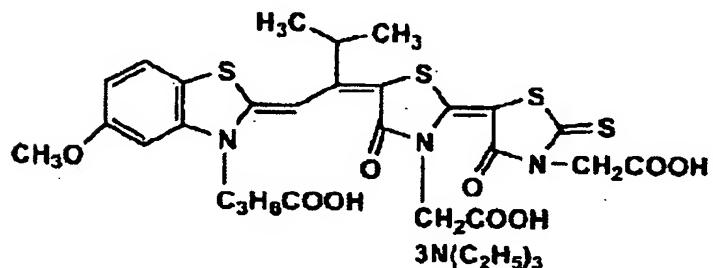
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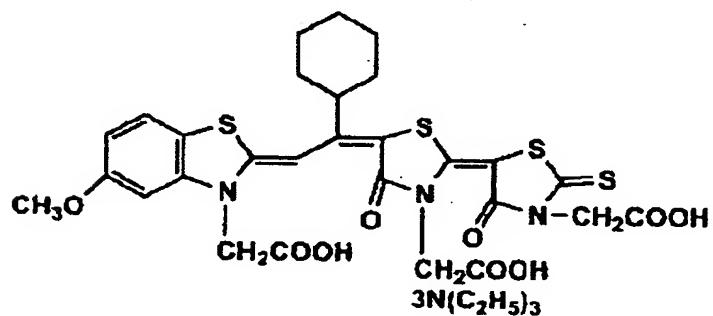
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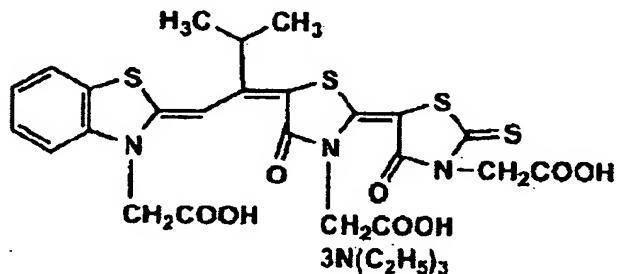
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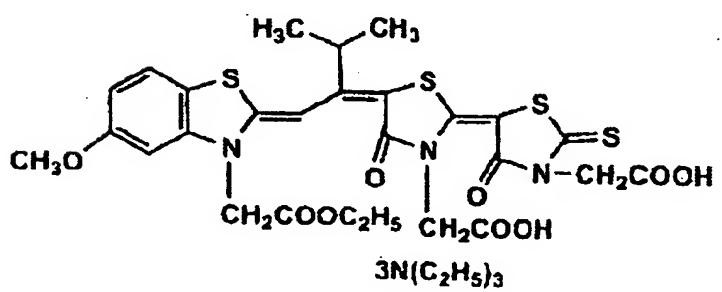
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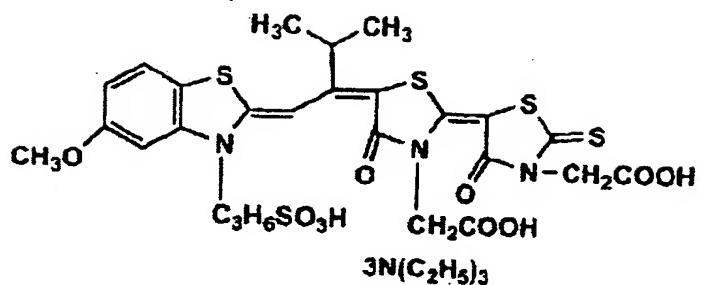
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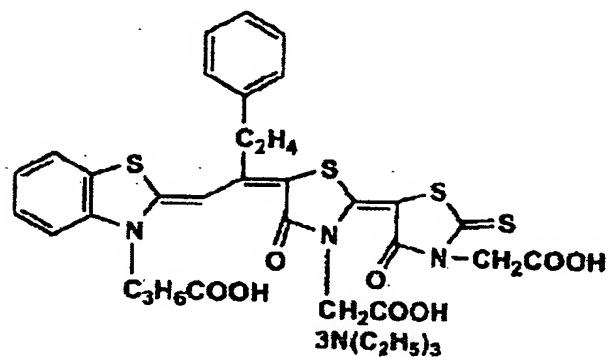
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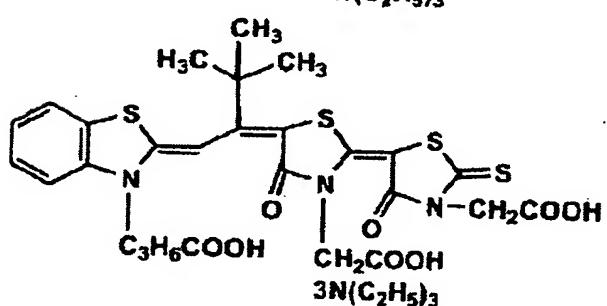
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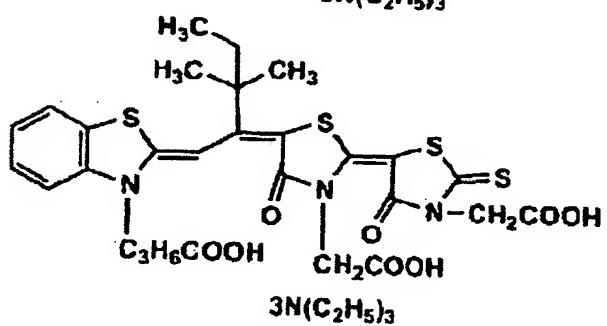
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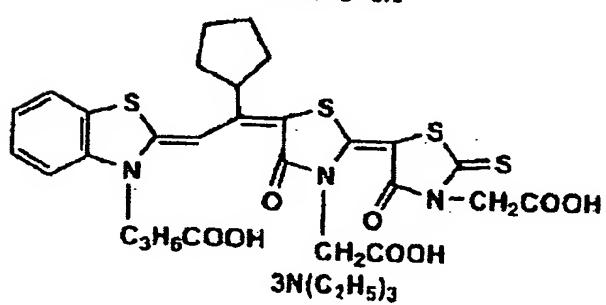
III-44



III-45



III-46



The dyes represented by the formula (III) can be readily synthesized by referring to the known methods described in, for example, F.M. Hamer, "Cyanine Dyes and Related Compounds" (published by Interscience Publishers, 1964), U.S. Patent Nos. 5 2,454,629, 2,493,748, JP-A-10-219125 and so forth.

Further, in the formula (IV), examples of the aliphatic group represented by R<sup>1</sup>, R<sup>2</sup>, R<sup>3</sup> or R<sup>5</sup> include, for example, a linear or branched alkyl group having 1 to 10 carbon atoms (e.g., methyl group, ethyl group, n-propyl group, n-pentyl group, isobutyl group etc.), an alkenyl group having 3 to 10 carbon atoms (e.g., 3-butenyl group, 2-propenyl group etc.), an aralkyl group having 3 to 10 carbon atoms (e.g., benzyl group, phenethyl group etc.) and so forth.

Examples of the aryl group represented by R<sup>1</sup>, R<sup>2</sup>, R<sup>3</sup> or R<sup>5</sup> include, for example, a phenyl group, and examples of the heterocyclic group represented by R<sup>1</sup>, R<sup>2</sup>, R<sup>3</sup> or R<sup>5</sup> include, for example, a pyridyl group (2-, 4-), a furyl group (2-), a thieryl group (2-), a sulfolanyl group, a tetrahydrofuryl group, a piperidinyl group and so forth. Each of the groups of R<sup>1</sup>, R<sup>2</sup>, R<sup>3</sup> and R<sup>5</sup> may be substituted with a substituent such as a halogen atom (e.g., fluorine atom, chlorine atom, bromine atom etc.), an alkoxy group (e.g., methoxy group, ethoxy group etc.), an aryloxy group (e.g., phenoxy group, p-tolyloxy group etc.), cyano group, a carbamoyl group (e.g., carbamoyl group, 25 N-methylcarbamoyl group, N,N-tetramethylenecarbamoyl group etc.), a sulfamoyl group (e.g., sulfamoyl group, N,N-3-oxapentamethyleneaminosulfonyl group etc.), methanesulfonyl

group, an alkoxy carbonyl group (e.g., ethoxycarbonyl group, butoxycarbonyl group etc.), an aryl group (e.g., phenyl group, carboxyphenyl group etc.) and an acyl group (e.g., acetyl group, benzoyl group etc.).

5 Examples of the water-solubilizing group substituting on  $R^1$ ,  $R^2$ ,  $R^3$ ,  $R^4$  or  $R^5$  include an acidic group such as sulfo group, carboxyl group, phosphono group, a sulfite group ( $-\text{SO}(\text{OR})_2$  where two of R may be the same or different and represent a group imparting water-solubility such as hydrogen atom or an alkali metal atom) and sulfino group.

10 Specific examples of the aliphatic group substituted with the water-solubilizing group include carboxymethyl group, sulfoethyl group, sulfopropyl group, sulfobutyl group, sulfopentyl group, 3-sulfobutyl group, 6-sulfo-3-oxahexyl group, 15  $\omega$ -sulfopropoxycarbonylmethyl group,  $\omega$ -sulfopropylaminocarbonylmethyl group, 3-sulfinobutyl, 3- phosphonopropyl, 4-sulfo-3-butenyl group, 2-carboxy-2-propenyl group, o-sulfobenzyl group, p-sulfophenethyl group, p-carboxybenzyl etc., specific examples of the aryl group 20 substituted with the water-solubilizing group include p-sulfophenyl group, p-carboxyphenyl group etc., and specific examples of the heterocyclic group substituted with the water-solubilizing group include 4-sulfothienyl group, 5-carboxypyridyl group etc.

25 In the formula (IV), it is preferred that  $R^1$  is an alkyl group substituted with sulfo group, and any two of  $R^2$ ,  $R^3$  and  $R^5$  represent carboxymethyl group.

The 5- or 6-membered nitrogen-containing heterocyclic ring and the condensed ring of the 5- or 6-membered nitrogen-containing heterocyclic ring which may have a condensed ring represented by  $Z^1$  may have a substituent at an arbitrary 5 position, and examples of the substituent include arbitrary groups such as a halogen atom (fluorine atom, chlorine atom, bromine atom, iodine atom), trifluoromethyl group, an alkoxy group (e.g., an unsubstituted alkoxy group such as methoxy group, ethoxy group and butoxy group, and a substituted alkoxy group such as 2-methoxyethoxy group and benzyloxy group), 10 hydroxyl group, cyano group, an aryloxy group (e.g., a substituted or unsubstituted aryloxy group such as phenoxy group and tolyloxy group), an aryl group (e.g., a substituted or unsubstituted aryl group such as phenyl group and p-chlorophenyl group), stilyl group, a heterocyclic group (e.g., 15 furyl group, thienyl group etc.), a carbamoyl group (e.g., carbamoyl group, N-ethylcarbamoyl group etc.), a sulfamoyl group (e.g., sulfamoyl group, N,N-dimethylsulfamoyl group etc.), an acylamino group (e.g., acetylamino group, propionylamino group, benzoylamino group etc.), an acyl group (e.g., acetyl group, benzoyl group etc.), an alkoxy carbonyl group (e.g., 20 ethoxycarbonyl group etc.), a sulfonamido group (e.g., methanesulfonylamido group, benzenesulfonamido group etc.), a sulfonyl group (e.g., methanesulfonyl group, p-toluenesulfonyl group etc.) and carboxyl group.

Examples of the group substituting on the methine group represented by  $L^1$  or  $L^2$  include, for example, a lower alkyl

group (an alkyl group having 1 to 6 carbon atoms, preferably an alkyl group having 1 to 4 carbon atoms, e.g., methyl group, ethyl group etc.), a phenyl group (e.g., phenyl group, carboxyphenyl group etc.), an alkoxy group (e.g., methoxy group, ethoxy group etc.), an aralkyl group (e.g., benzyl group etc.) and so forth.

When either one of the carbon atoms of the methine groups represented by  $L^1$  and  $L^2$  is substituted, the sensitizing dyes represented by the formula (IV) generally show high spectral 10 sensitivity and a characteristic that they are likely to be breached in a processing bath and exhibit a preferred effect of reduced staining with residual color.

$M^1$  represents a cation or an acid anion. Examples of the cation include proton, an organic ammonium ion (e.g., 15 triethylammonium, triethanolammonium ions etc.) and an inorganic cation (e.g., those of lithium, sodium, calcium etc.), and examples of the acid anion include, for example, a halogen ion (e.g., chloride ion, bromide ion, iodide ion etc.), p-toluenesulfonate ion, perchlorate ion, 4-fluoroboron ion etc.

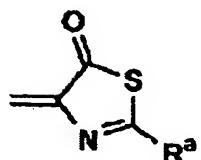
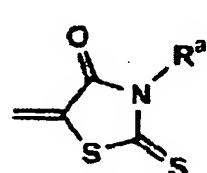
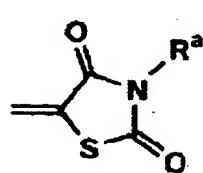
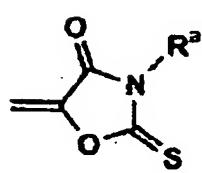
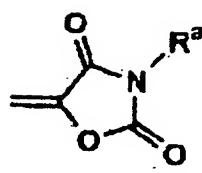
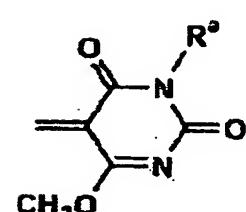
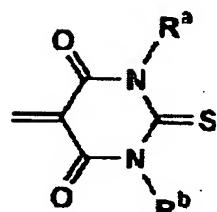
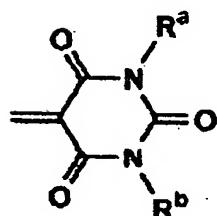
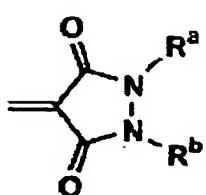
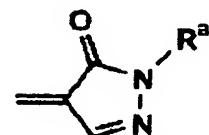
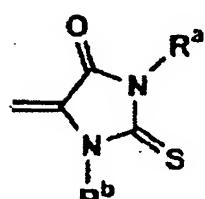
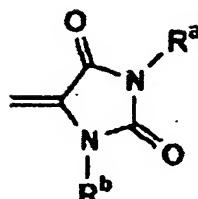
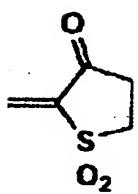
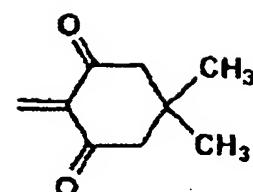
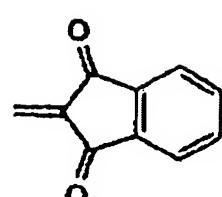
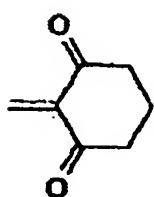
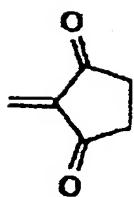
20 When an intramolecular salt is formed and the total intramolecular charge is offset,  $n^1$  is 0.

The electron-withdrawing group represented by  $E^1$  or  $E^2$  is chosen from groups having a Hammett's  $\sigma$  value of 0.3 or larger. Specific examples include cyano group, a carbamoyl group (e.g., 25 carbamoyl group, morpholinocarbonyl group, N-methylcarbamoyl group etc.), an alkoxy carbonyl group (e.g., methoxycarbonyl group, ethoxycarbonyl group etc.), a sulfamoyl group (e.g.,

sulfamoyl group, morpholinosulfonyl group, N,N-dimethylsulfamoyl group etc.), an acyl group (e.g., acetyl group, benzoyl group etc.), a sulfonyl group (e.g., methanesulfonyl group, ethanesulfonyl group, benzenesulfonyl group, toluenesulfonyl group etc.) and so forth.

The Hammett's  $\sigma$  value is a substituent constant obtained by Hammett et al. from electronic effect of substituent exerted on hydrolysis of benzoic acid ester, and is detailed in *Journal of Organic Chemistry*, vol. 23, pp.420-427 (1958); *Jikken Kagaku Koza* (Lecture of Experimental Chemistry), vol. 14 (Maruzen Shuppan); *Physical Organic Chemistry* (McGraw Hill Book, 1940); *Drug Design*, vol. VII (Academic Press, New York, 1976); *Yakubutsu no Kozo Kassei Sukan* (Relationship of Structural Activities of Drugs (Nankodo, 1979) and so forth.

Examples of the  $=C(E^1)(E^2)$  group in which  $E^1$  and  $E^2$  bind to each other to form a keto ring or acidic heterocyclic ring group include, for example, the groups shown below.



In the aforementioned groups,  $R^a$  and  $R^b$  each independently represent a lower alkyl group, an aryl group or a heterocyclic group, and specific examples of the lower alkyl group include

substituted or unsubstituted groups such as methyl group, ethyl group, propyl group, 2-hydroxyethyl group, 2-methoxyethyl group, trifluoroethyl group, allyl group, carboxymethyl group, carboxyethyl group, 2-sulfoethyl group and benzyl group.

5 Examples of the aforementioned aryl group and heterocyclic group include, for example, those mentioned for R<sup>1</sup> to R<sup>5</sup>.

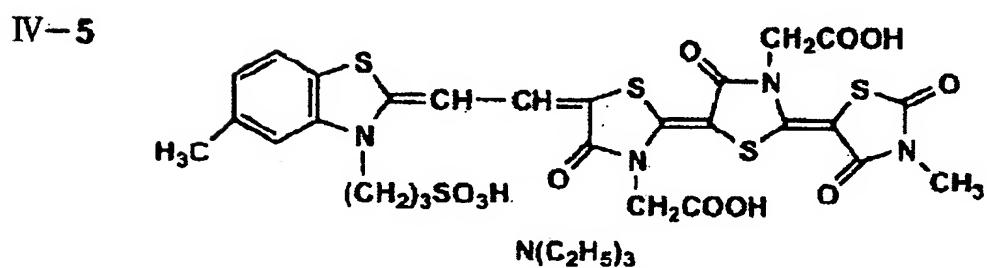
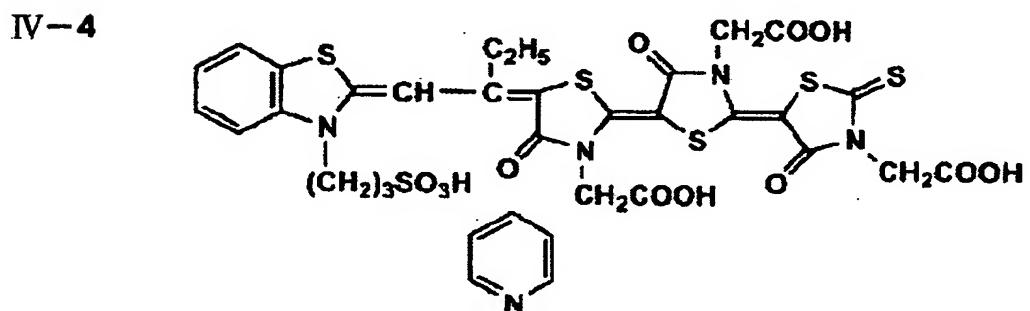
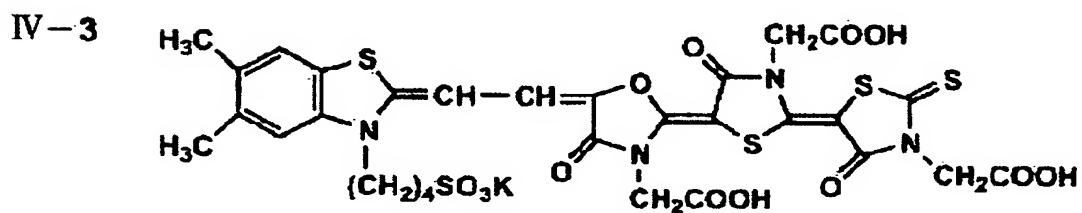
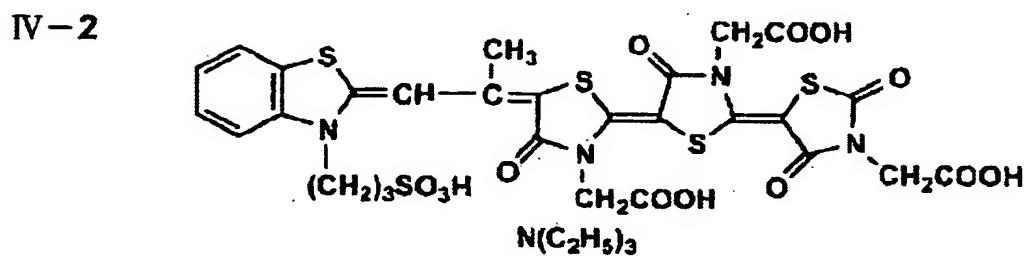
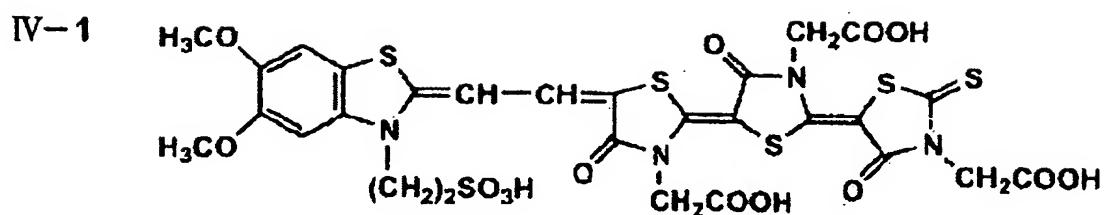
M<sup>1</sup> represents a cation or an acid anion. Examples of the cation include proton, an organic ammonium ion (e.g., triethylammonium, triethanolammonium ions etc.) and an

10 inorganic cation (e.g., those of lithium, sodium, potassium etc.), and examples of the acid anion include, for example, a halogen ion (e.g., chloride ion, bromide ion, iodide ion etc.), p-toluenesulfonate ion, perchlorate ion, 4-fluoroboron ion etc.

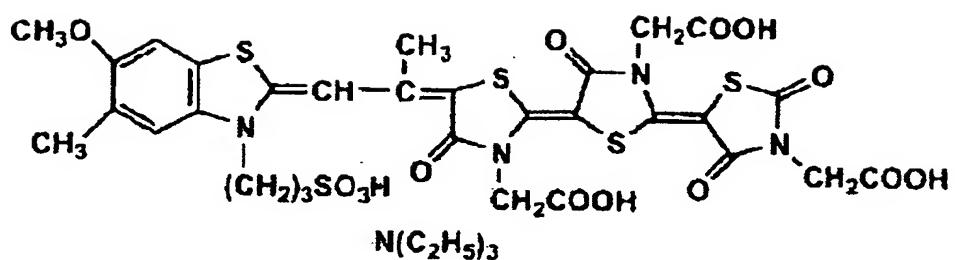
When an intramolecular salt is formed and the total

15 intramolecular charge is offset, n<sup>1</sup> is 0.

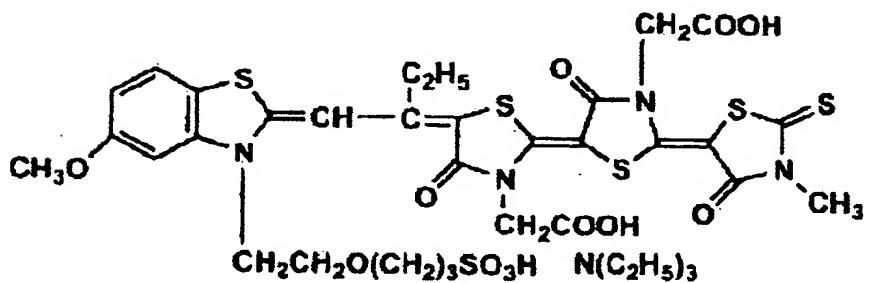
Specific examples of the sensitizing dyes represented by the formula (IV) will be listed below. However, dyes represented by the formula (IV) that can be used for the present invention are not limited to these.



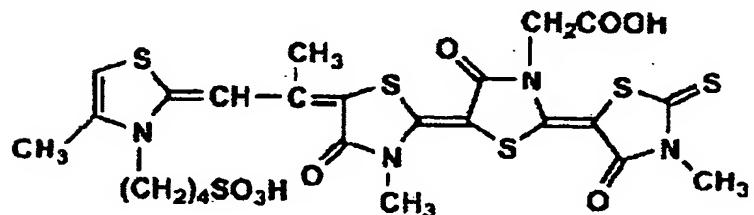
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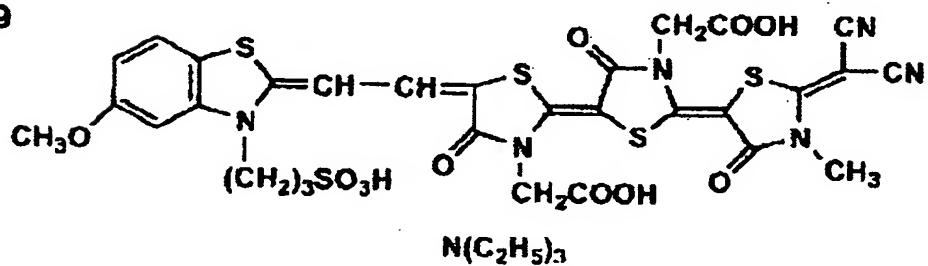
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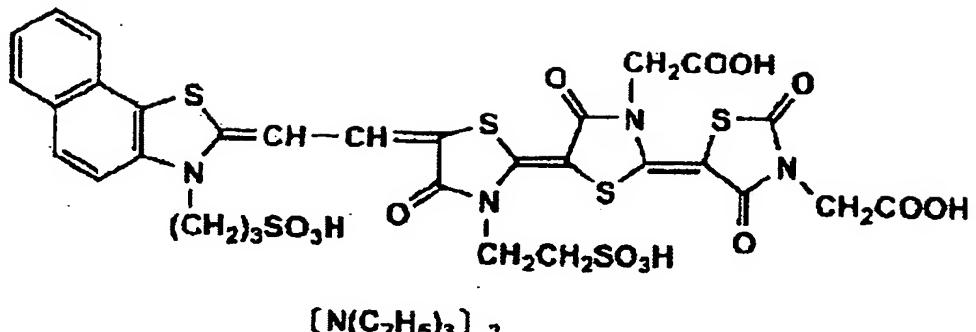
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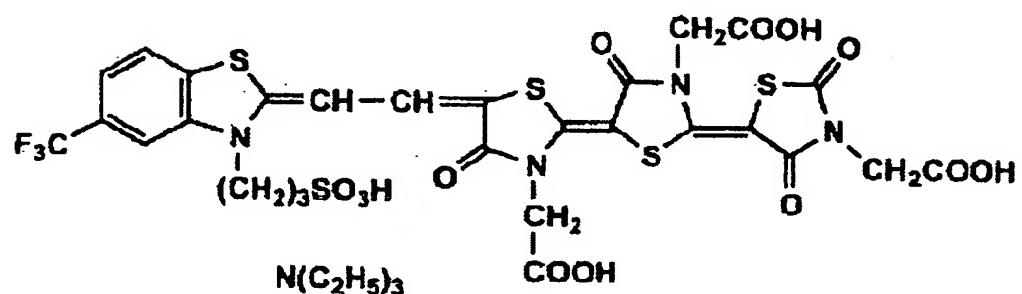
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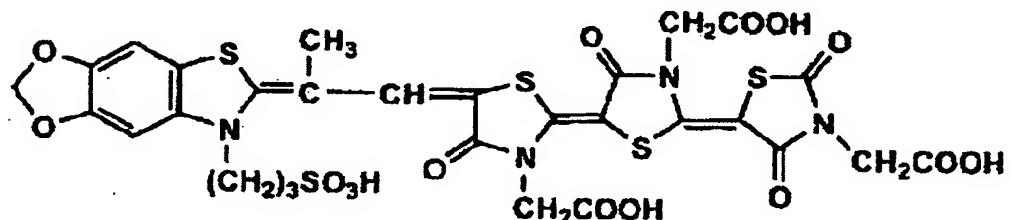
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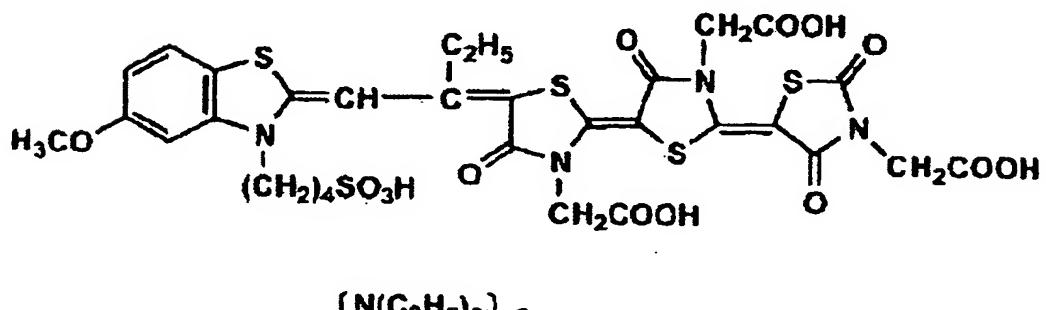
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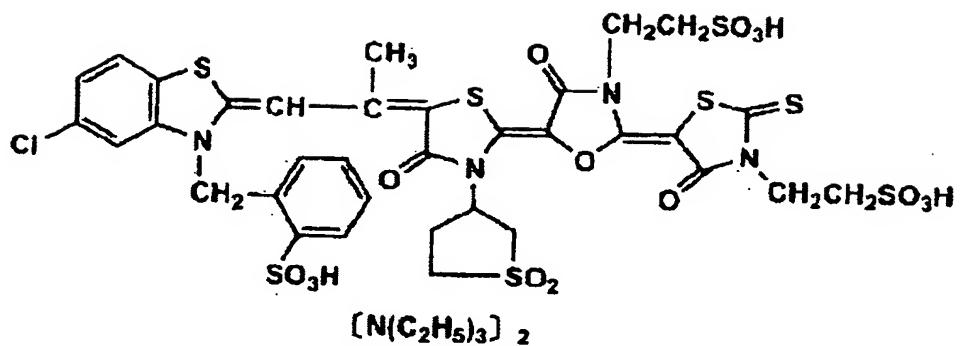
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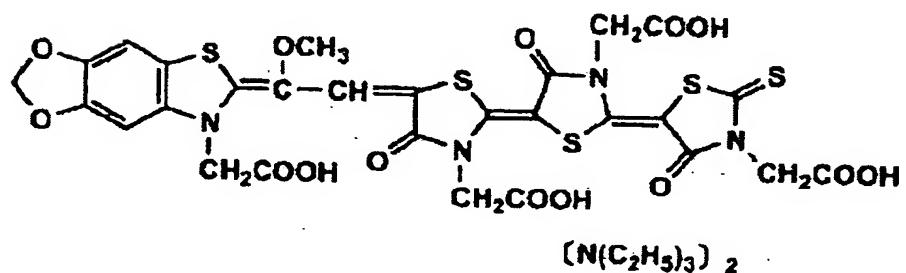
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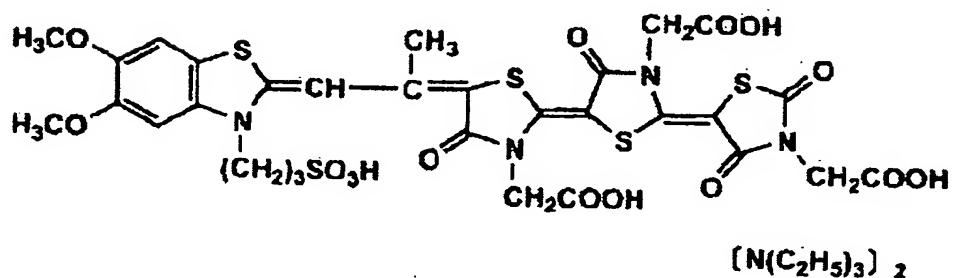
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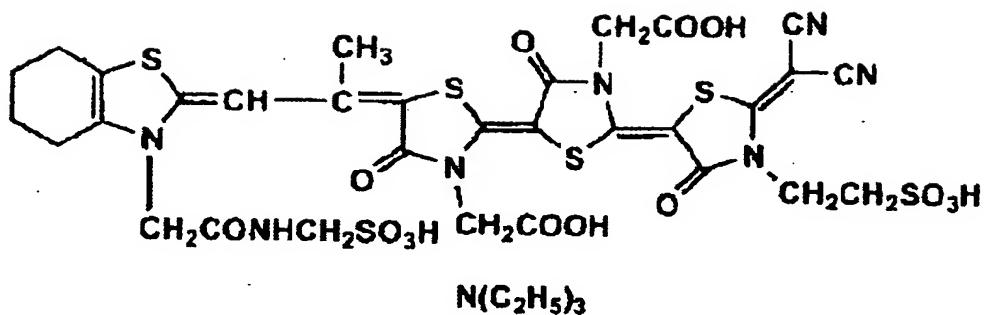
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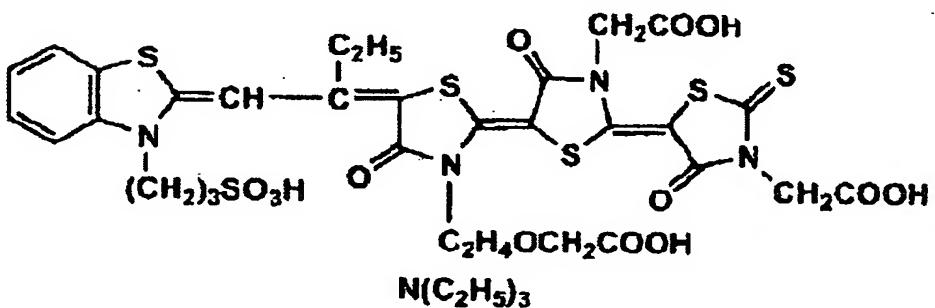
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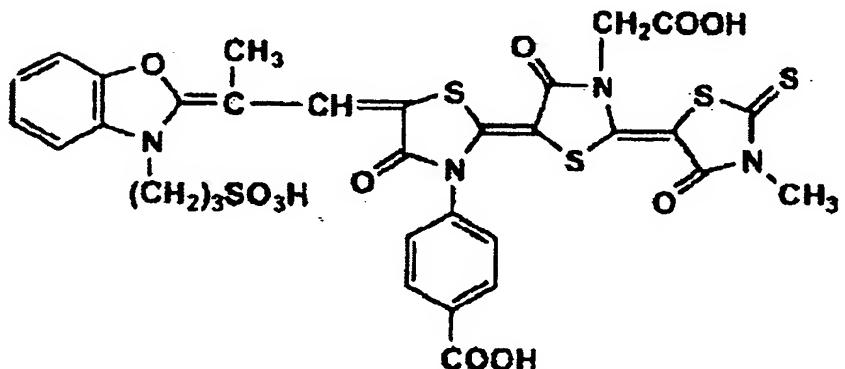
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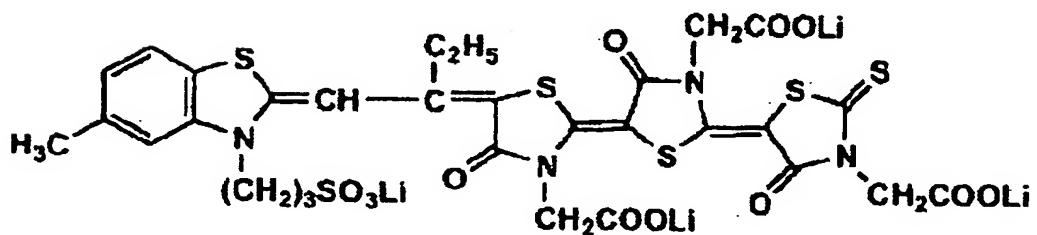
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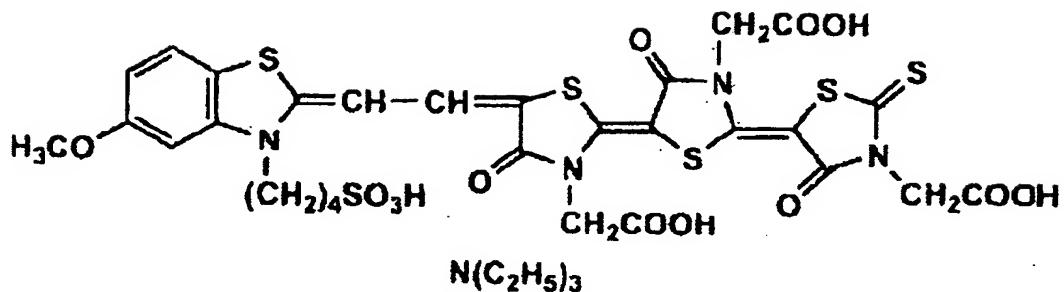
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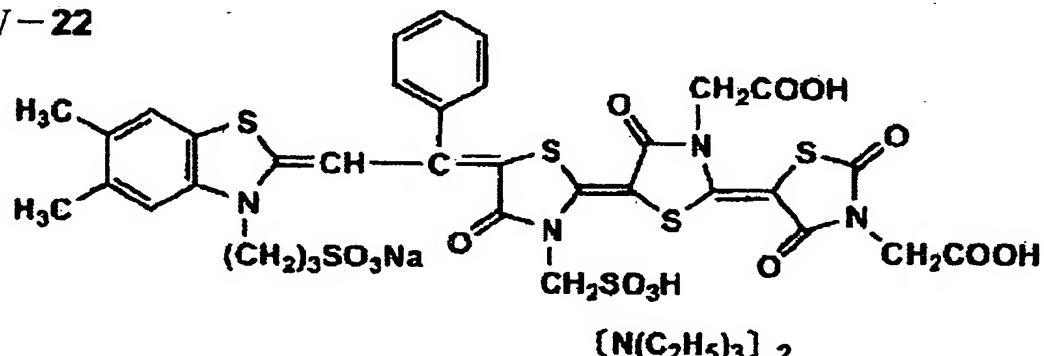
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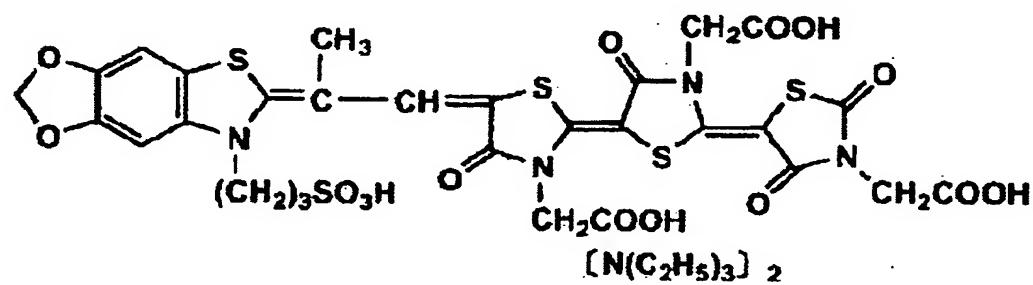
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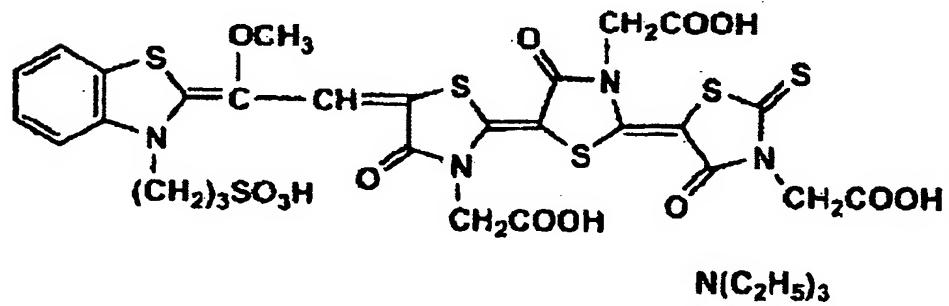
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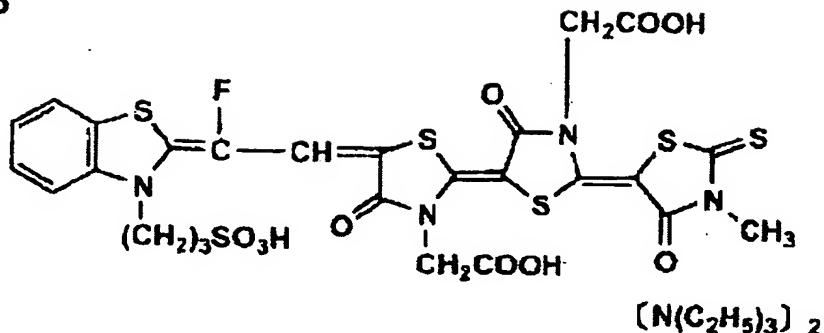
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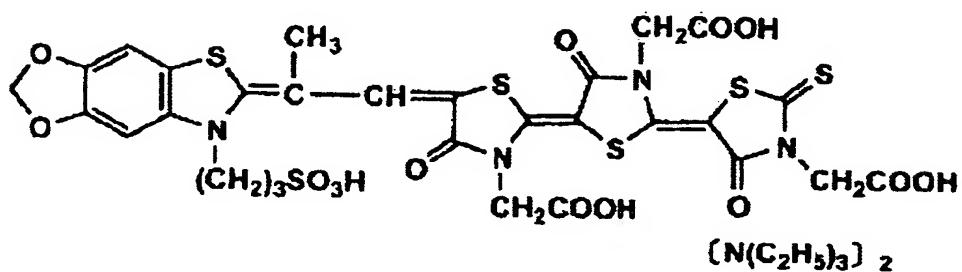
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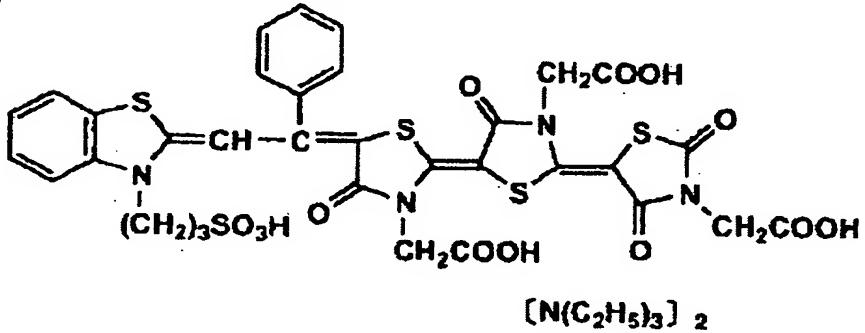
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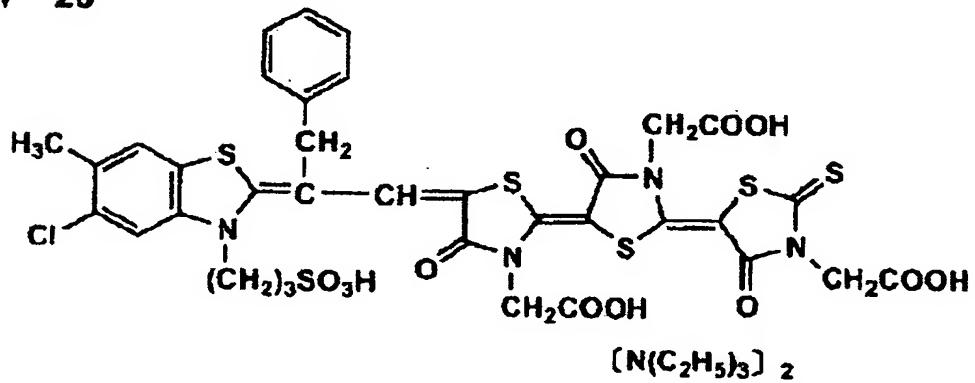
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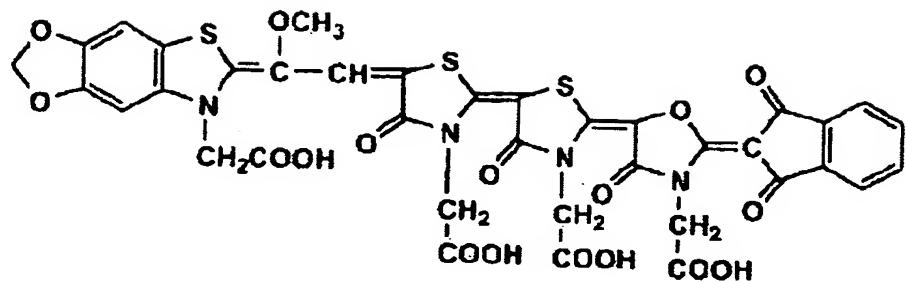
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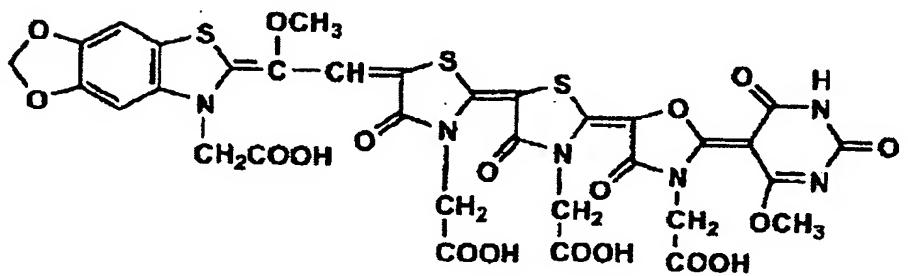
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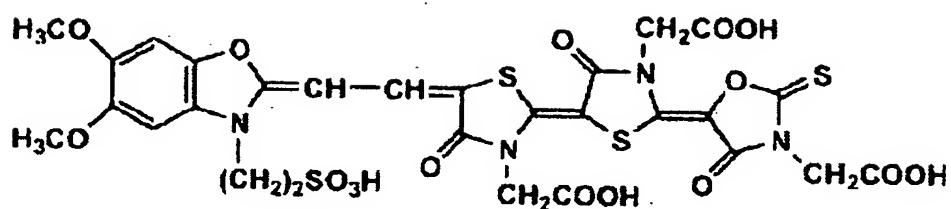
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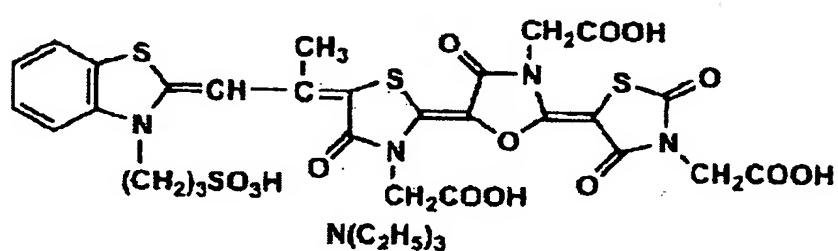
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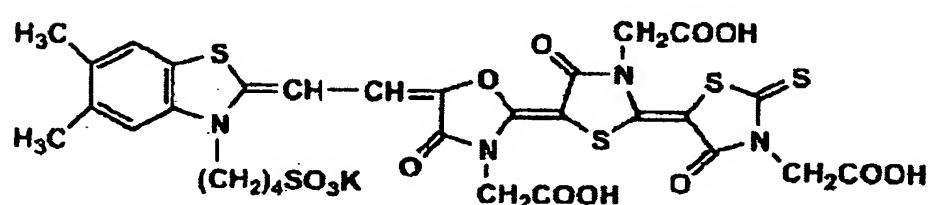
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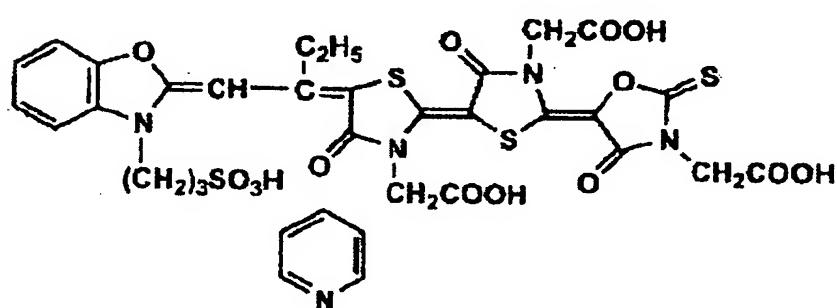
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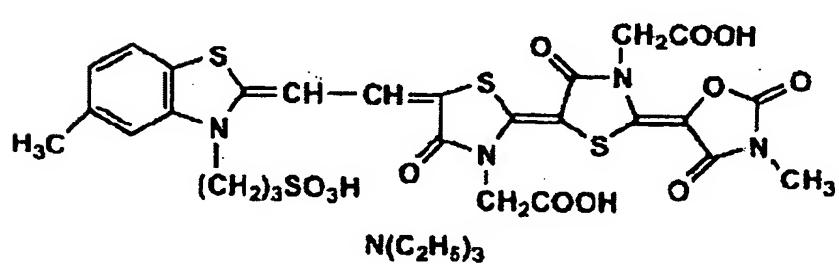
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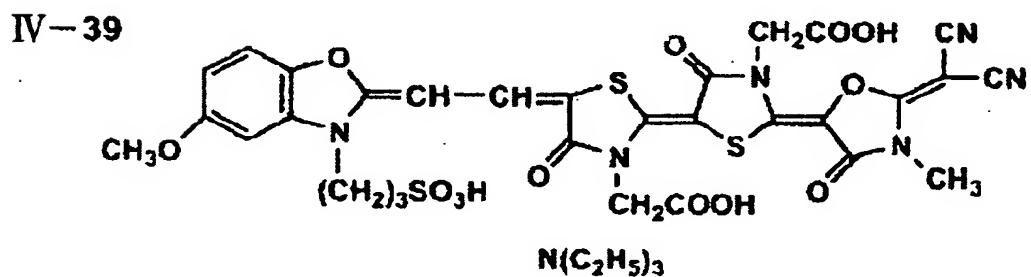
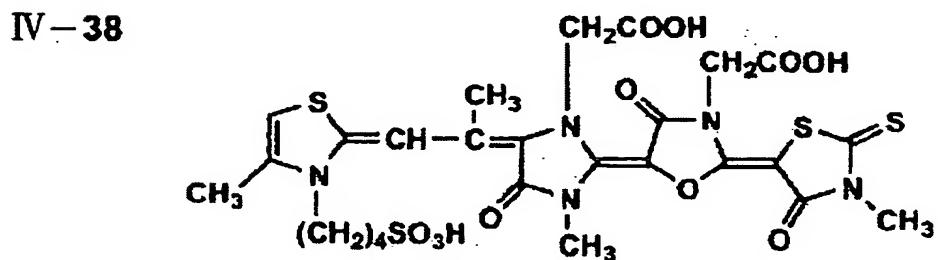
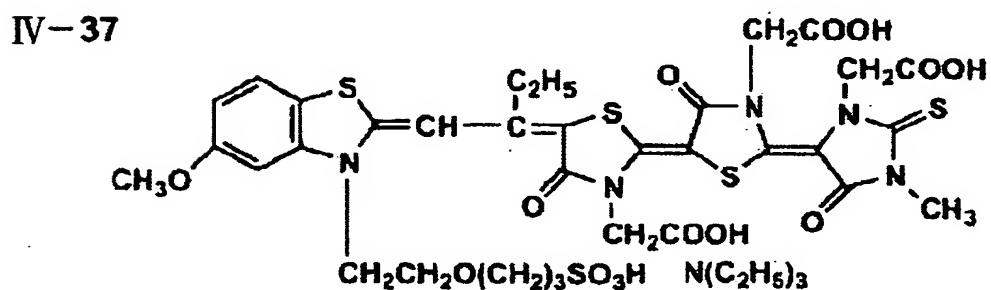
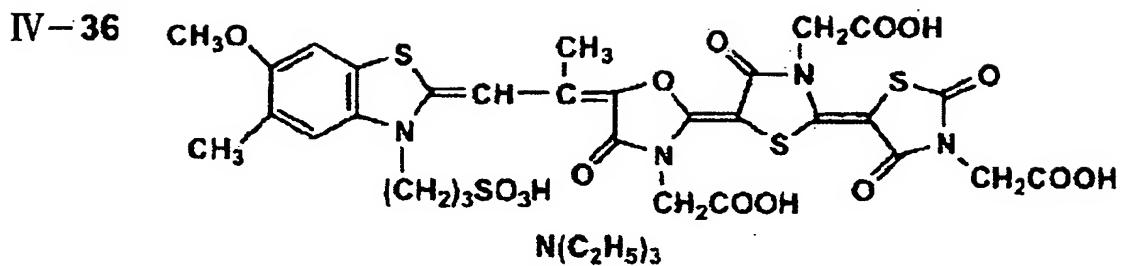


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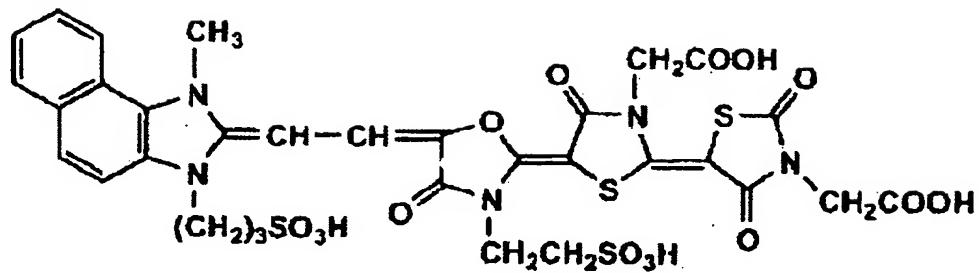


IV-35



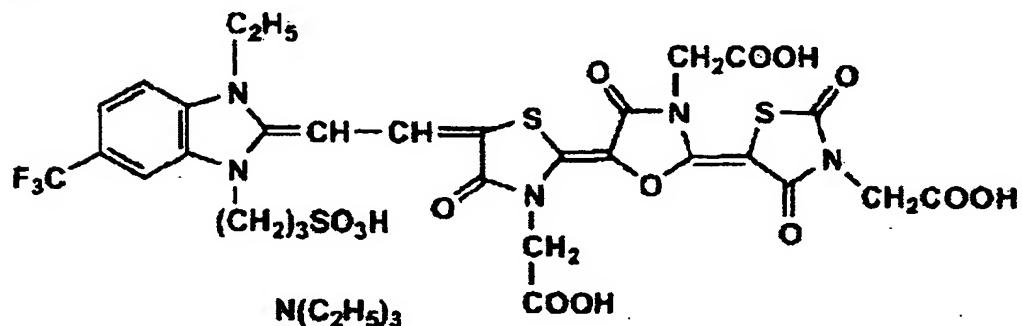


IV-40

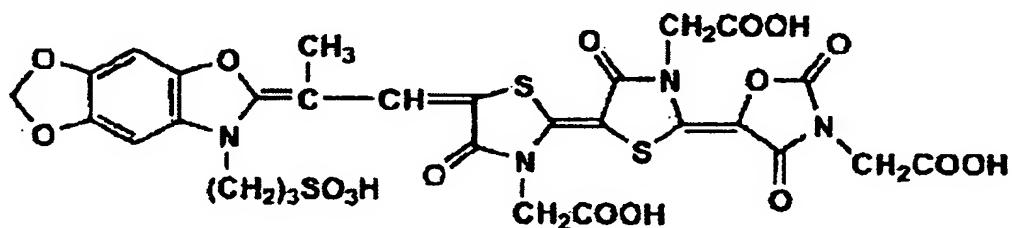


$[\text{N}(\text{C}_2\text{H}_5)_3]_2$

IV-41

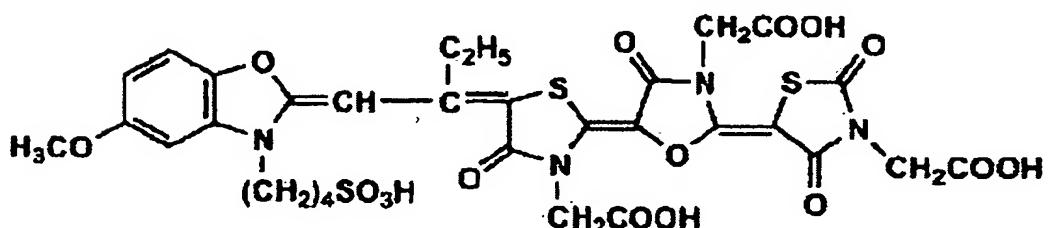


IV-42



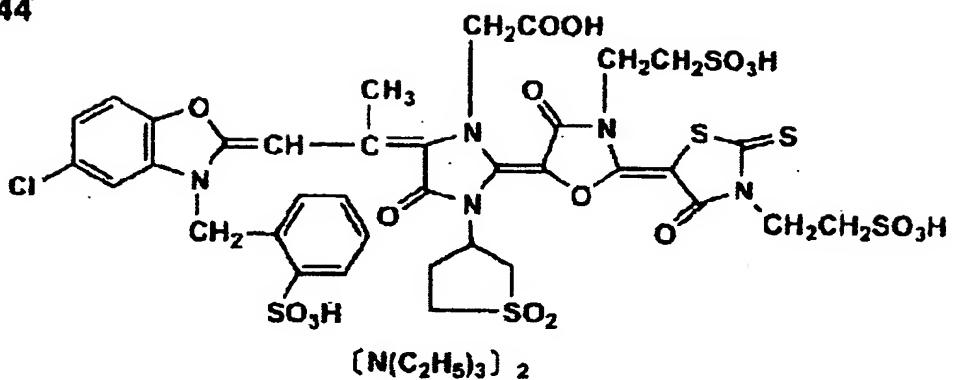
$[\text{N}(\text{C}_2\text{H}_5)_3]_2$

IV-43

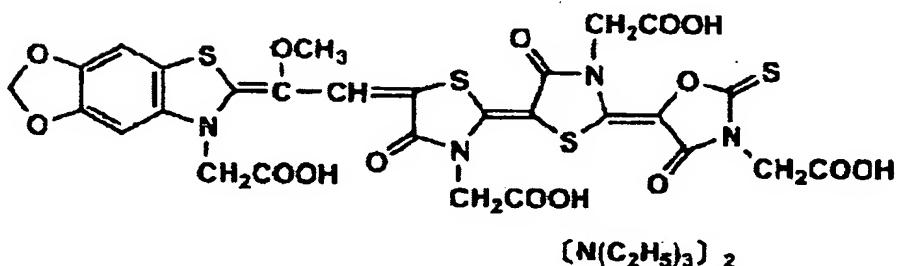


$[\text{N}(\text{C}_2\text{H}_5)_3]_2$

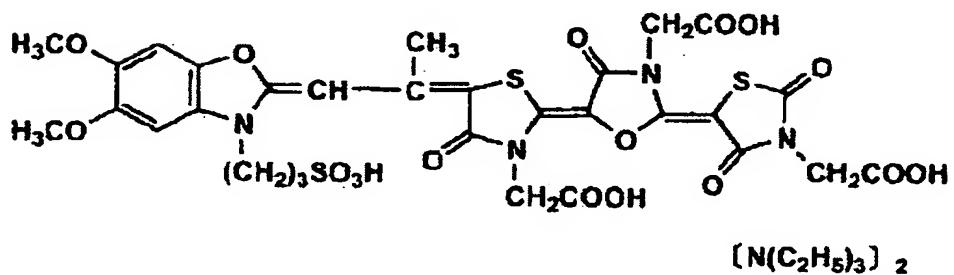
IV-44



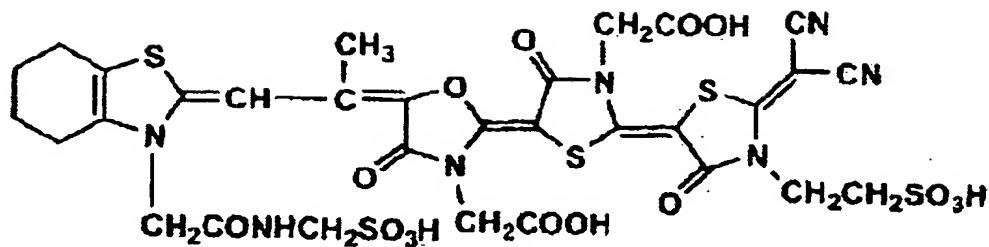
IV-45



IV-46

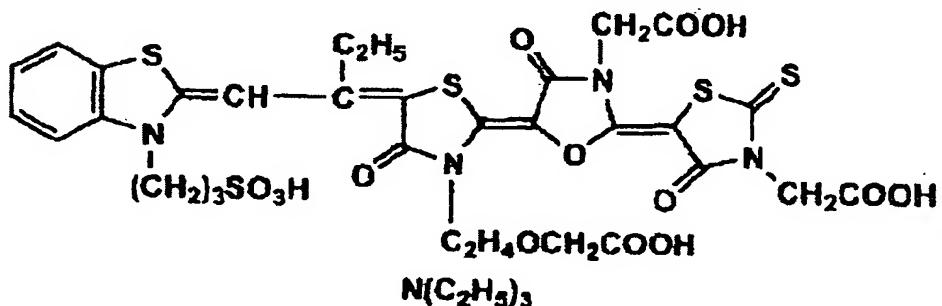


IV-47

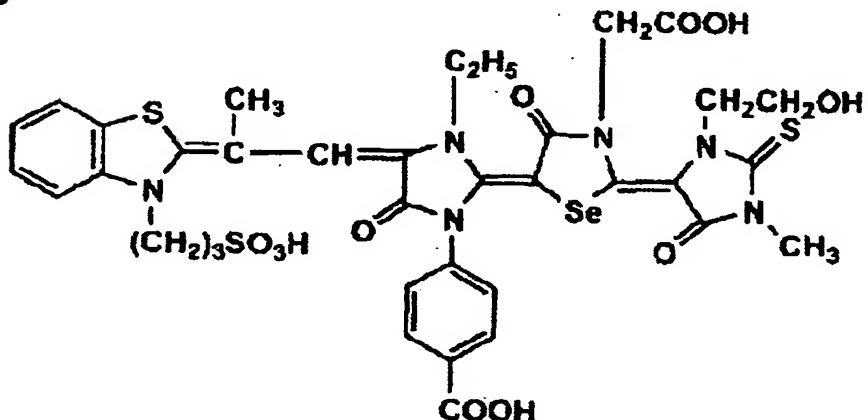


$N(C_2H_5)_3$

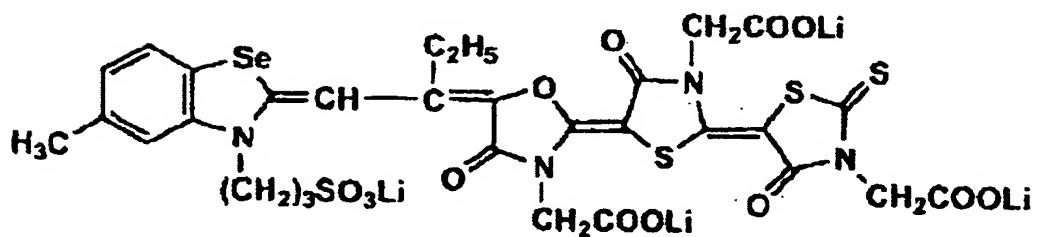
IV-48



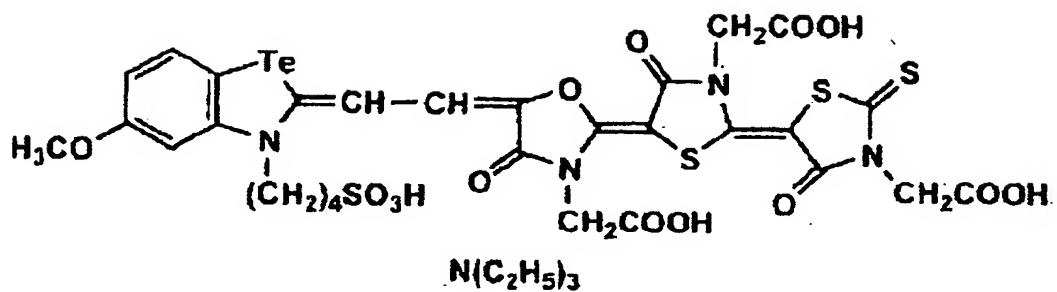
IV-49



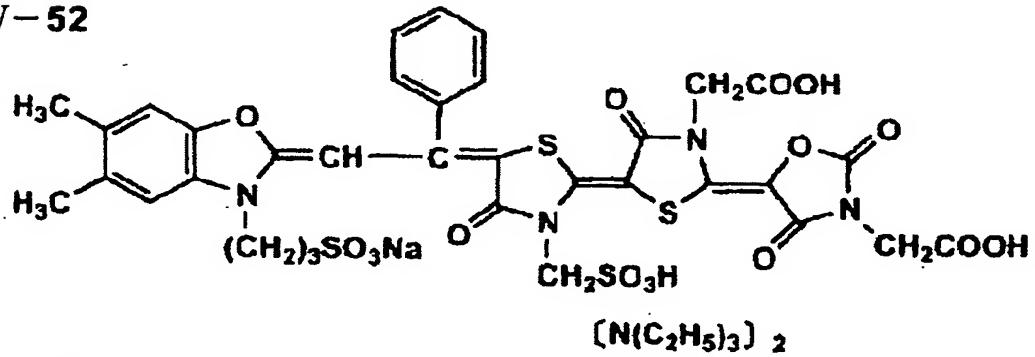
IV-50



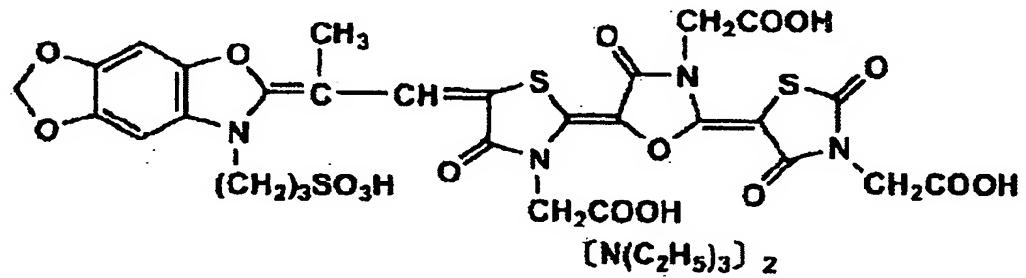
IV-51



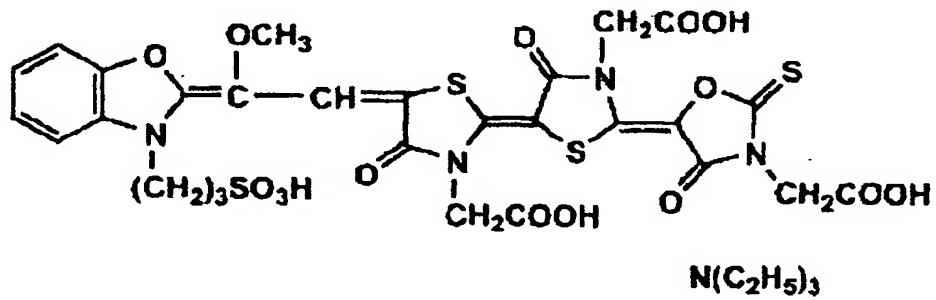
IV-52



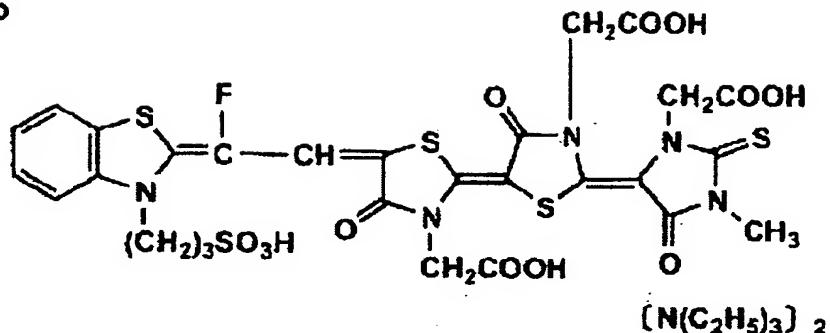
IV-53



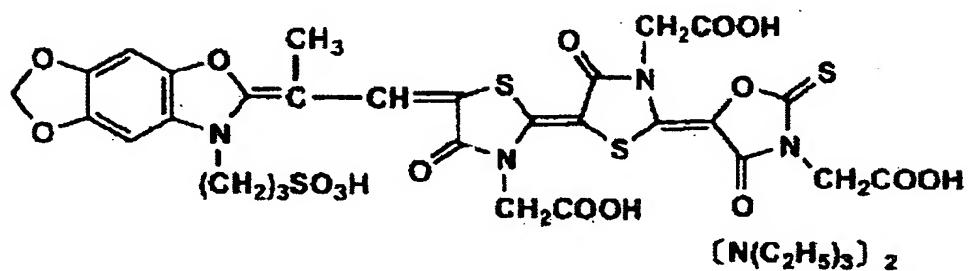
IV-54



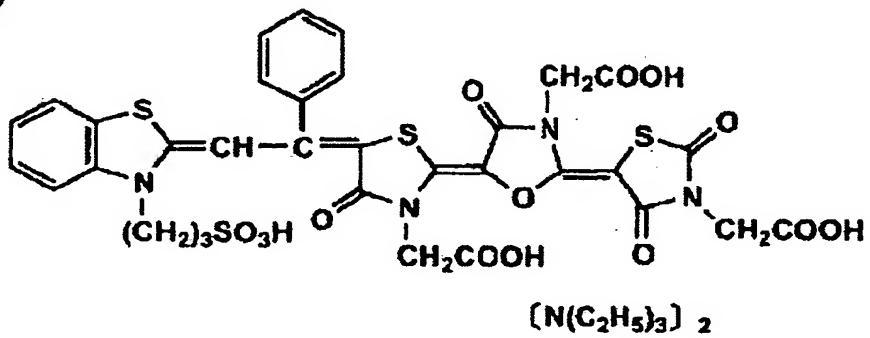
IV-55



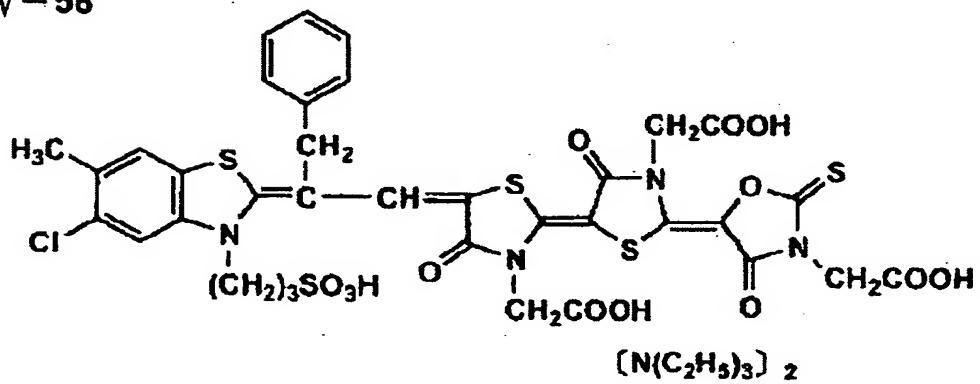
IV-56



IV-57



IV-58



The aforementioned compounds can be readily synthesized by referring to the known methods described in, for example, F.M. Hamer, "Cyanine Dyes and Related Compounds" (published by Interscience Publishers, 1964), U.S. Patent Nos. 2,454,629, 5 2,493,748, British Patent No. 489,335, European Patent Publication No. 730,008 and so forth.

The sensitizing dyes of the formulas (I) to (IV) may be used individually or in combination, and a combination of sensitizing dyes is often used for the purpose of, in 10 particular, supersensitization. In combination with these sensitizing dyes, a dye which itself has no spectral sensitization effect, or a material that absorbs substantially no visible light, but exhibits supersensitization may be incorporated into the emulsion.

15 Useful sensitizing dyes, combinations of dyes that exhibit supersensitization and materials that show supersensitization are described in, for example, Research Disclosure, Vol. 176, 17643, page 23, Item IV-J (December 1978); Japanese Patent Publication (KOKOKU, henceforth referred 20 to as "JP-B") No. 49-25500, JP-B-43-4933, JP-A-59-19032, JP-A- 59-192242 and so forth.

The sensitizing dyes used for the present invention are preferably dissolved in water in an amount of 0.05 weight % or more. The sensitizing dyes used for the present invention may 25 be used in a combination of two or more of them. The sensitizing dye may be added to a silver halide emulsion by dispersing it directly in the emulsion, or by dissolving it in

a sole or mixed solvent of such solvents as water, methanol, ethanol, propanol, acetone, methyl cellosolve, 2,2,3,3-tetrafluoropropanol, 2,2,2-trifluoroethanol, 3-methoxy-1-propanol, 3-methoxy-1-butanol, 1-methoxy-2-propanol or N,N-5 dimethylformamide, and then adding the solution to the emulsion.

Alternatively, the sensitizing dye may be added to the emulsion by the method disclosed in U.S. Patent No. 3,469,987, in which a dye is dissolved in a volatile organic solvent, the solution is dispersed in water or a hydrophilic colloid, and 10 the dispersion is added to the emulsion; a method disclosed in JP-B-44-23389, JP-B-44-27555, JP-B-57-22091 or the like, in which a dye is dissolved in an acid and the solution is added to the emulsion, or a dye is made into an aqueous solution in the presence of an acid or base and the solution is added to 15 the emulsion; a method disclosed in U.S. Patent Nos. 3,822,135, 4,006,025 or the like, in which a dye is made into an aqueous solution or a colloid dispersion in the presence of a surfactant, and the solution or dispersion is added to the emulsion; the method disclosed in JP-A-53-102733 and JP-A-58-20 105141, in which a dye is directly dispersed in a hydrophilic colloid and the dispersion is added to the emulsion; or the method disclosed in JP-A-51-74624, in which a dye is dissolved by using a compound capable of causing red-shift and the solution is added to the emulsion. Ultrasonic waves may also be 25 used for the preparation of the solution.

The sensitizing dye used for the present invention may be added to a silver halide emulsion at any step known to be

useful during the preparation of the emulsion. For example, the dye may be added at a step of formation of silver halide grains and/or in a period before desalting or at a step of desilverization, and/or in a period after desalting and before 5 initiation of chemical ripening, as disclosed in, for example, U.S. Patent Nos. 2,735,766, 3,628,960, 4,183,756, 4,225,666, JP-A-58-184142, JP-A-60-196749 etc., or the dye may be added in any period or at any step before coating of the emulsion, such as immediately before or during chemical ripening, or in a 10 period after chemical ripening but before coating, as disclosed in JP-A-58-113920 or the like. Further, a sole kind of compound alone or compounds different in structure in combination may be added as divided portions, for example, a part is added during grain formation, and the remaining during chemical ripening or 15 after completion of the chemical ripening, or a part is added before or during chemical ripening and the remaining after completion of the chemical ripening, as disclosed in U.S. Patent No. 4,225,666, JP-A-58-7629 or the like. The kind of compound or the kind of the combination of compounds added as 20 divided portions may also be changed.

The addition amount of the sensitizing dye used for the silver halide photographic light-sensitive material of the present invention varies depending on the shape, size, halogen composition of silver halide grains, method and degree of 25 chemical sensitization, kind of antifoggant and so forth, but the addition amount is preferably  $4 \times 10^{-6}$  to  $8 \times 10^{-3}$  mol per mol of silver halide. For example, when the silver halide grain

size is 0.2 to 1.3  $\mu\text{m}$ , the addition amount is preferably  $2 \times 10^{-7}$  to  $3.5 \times 10^{-6}$ , more preferably  $6.5 \times 10^{-7}$  to  $2.0 \times 10^{-6}$  mol, per 1  $\text{m}^2$  of the surface area of silver halide grains.

As for silver halide of the silver halide emulsion used  
5 for the silver halide photographic light-sensitive material of  
the present invention, any combination of silver halides may be  
used. However, silver halides having a silver bromide content  
of 40 to 90 mol %, in particular, silver chlorobromide and  
silver chloroiodobromide having a silver bromide content of 40  
10 to 90 mol %, are preferred. More preferred silver bromide  
content is 40 to 75 mol %. The form of silver halide grain may  
be any of a cubic, tetradecahedral, octahedral, variable and  
tabular forms, but a cubic form is preferred. The silver halide  
preferably has a mean grain size of 0.1 to 0.7  $\mu\text{m}$ , more  
15 preferably 0.1 to 0.5  $\mu\text{m}$ , and preferably has a narrow grain  
size distribution in terms of a variation coefficient, which is  
represented as  $\{( \text{Standard deviation of grain size} ) / ( \text{mean grain size} )\} \times 100$ , of preferably 15% or less, more preferably 10% or  
less.

20 The silver halide grains may have uniform or different  
phases for the inside and the surface layer. Further, they may  
have a localized layer having a different halogen composition  
inside the grains or as surface layers of the grains.

25 The photographic emulsion used for the present invention  
can be prepared using the methods described in P. Glafkides,  
Chimie et Physique Photographique, Paul Montel (1967); G.F.  
Duffin, Photographic Emulsion Chemistry, The Focal Press

(1966); V.L. Zelikman et al, Making and Coating Photographic Emulsion, The Focal Press (1964) and so forth.

Specifically, any of the acidic process and the neutral process may be used. In addition, a soluble silver salt may be 5 reacted with a soluble halogen salt by any of the single jet method, double jet method and a combination thereof. A method of forming grains in the presence of excessive silver ions (so-called reverse mixing method) may also be used.

As one kind of the double jet method, a method of 10 maintaining the pAg constant in the liquid phase where silver halide is produced, that is, the so-called controlled double jet method may also be used. Further, it is preferable to form grains using the so-called silver halide solvent such as ammonia, thioether or tetra-substituted thiourea. Preferred 15 silver halide solvents are tetra-substituted thiourea compounds, and they are described in JP-A-53-82408 and JP-A-55-77737.

Preferred examples of the thiourea compounds include tetramethylthiourea and 1,3-dimethyl-2-imidazolidinethione. While the amount of the silver halide solvent to be added may 20 vary depending on the kind of the silver halide solvent used, the desired grain size and halide composition of silver halide to be desired,  $10^{-5}$  to  $10^{-2}$  mol per mol of silver halide is preferred.

According to the methods of forming grains using 25 controlled double jet method and a silver halide solvent, a silver halide emulsion comprising regular crystal form grains and having a narrow grain size distribution can be easily

prepared, and these methods are useful for preparing the silver halide emulsion used for the present invention.

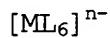
Further, in order to achieve a uniform grain size, it is preferable to rapidly grow grains within the range of not exceeding the critical saturation degree by using a method of changing the addition rate of silver nitrate or alkali halide according to the grain growth rate as described in British Patent No. 1,535,016, JP-B-48-36890 and JP-B-52-16364, or a method of changing the concentration of the aqueous solution as described in U.S. Patent No. 4,242,445 and JP-A-55-158124.

The silver halide emulsion used for the present invention may contain a metal belonging to Group VIII. In particular, it is preferable to add a rhodium compound, iridium compound or ruthenium compound in order to achieve high contrast and low fog. Further, to attain higher sensitivity, it is effective to dope a hexacyanide metal complex such as  $K_4[Fe(CN)_6]$ ,  $K_4[Ru(CN)_6]$  and  $K_3[Cr(CN)_6]$ .

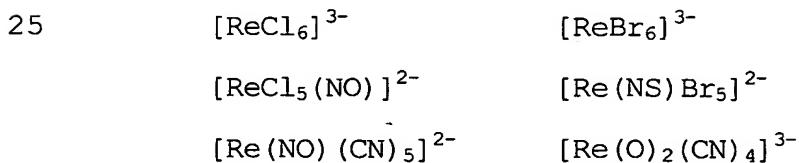
As the rhodium compound used for the present invention, a water-soluble rhodium compound can be used. Examples thereof include rhodium(III) halide compounds and rhodium complex salts having a halogen, amine, oxalato, aquo or the like as a ligand, such as hexachlororhodium(III) complex salt, pentachloroquorhodium complex salt, tetrachlorodiaquorhodium complex salt, hexabromorhodium(III) complex salt, hexaaminerhodium(III) complex salt and trioxalatorhodium(III) complex salt. The rhodium compound is dissolved in water or an appropriate solvent prior to use, and a method commonly used

for stabilizing the rhodium compound solution, that is, a method of adding an aqueous solution of hydrogen halide (e.g., hydrochloric acid, hydrobromic acid or hydrofluoric acid) or an alkali halide (e.g., KCl, NaCl, KBr, NaBr etc.) may be used. In place of using a water-soluble rhodium compound, separate silver halide grains that have been previously doped with rhodium may be added and dissolved at the time of preparation of silver halide.

The rhenium, ruthenium or osmium compound used for the present invention is added in the form of a water-soluble complex salt described in JP-A-63-2042, JP-A-1-285941, JP-A-2-20852, JP-A-2-20855 and so forth. Particularly preferred examples are six-coordinate complex salts represented by the following formula:



In the formula, M represents Ru, Re or Os, L represents a ligand, and n represents 0, 1, 2, 3 or 4. In this case, the counter ion plays no important role, and an ammonium or alkali metal ion may be used. Preferred examples of the ligand include a halide ligand, cyanide ligand, cyan oxide ligand, nitrosyl ligand, thionitrosyl ligand and so forth. Specific examples of the complex that can be used for the present invention are shown below. However, the complexes usable in the present invention are not limited to these.



	$[\text{RuCl}_6]^{3-}$	$[\text{RuCl}_4(\text{H}_2\text{O})_2]^{1-}$
	$[\text{RuCl}_5(\text{H}_2\text{O})]^{2-}$	$[\text{RuBr}_5(\text{NS})]^{2-}$
	$[\text{Ru}(\text{CO})_3\text{Cl}_3]^{2-}$	$[\text{Ru}(\text{CO})\text{Cl}_5]^{2-}$
	$[\text{Ru}(\text{CO})\text{Br}_5]^{2-}$	$[\text{OsCl}_6]^{3-}$
5	$[\text{OsCl}_5(\text{NO})]^{2-}$	$[\text{Os}(\text{NO})(\text{CN})_5]^{2-}$
	$[\text{Os}(\text{NS})\text{Br}_5]^{2-}$	$[\text{Os}(\text{CN})_6]^{4-}$
		$[\text{Os}(\text{O})_2(\text{CN})_4]^{4-}$

The amount of these compounds is preferably  $1 \times 10^{-9}$  to  $1 \times 10^{-5}$  mol, particularly preferably  $1 \times 10^{-8}$  to  $1 \times 10^{-6}$  mol, per mole of silver halide.

The iridium compounds used in the present invention include hexachloroiridium, hexabromoiridium, hexaammineiridium, pentachloronitrosyliridium and so forth. The iron compounds used in the present invention include potassium hexacyanoferrate(II) and ferrous thiocyanate.

The silver halide emulsion used for the present invention is preferably subjected to chemical sensitization. The chemical sensitization may be performed by using a known method such as sulfur sensitization, selenium sensitization, tellurium sensitization, noble metal sensitization or the like. These sensitization methods may be used each alone or in any combination. When these sensitization methods are used in combination, preferred combinations include sulfur and gold sensitizations, sulfur, selenium and gold sensitizations, sulfur, tellurium and gold sensitizations and so forth.

The sulfur sensitization used in the present invention is

usually performed by adding a sulfur sensitizer and stirring the emulsion at a high temperature of 40°C or above for a predetermined time. The sulfur sensitizer may be a known compound, and examples thereof include, in addition to the 5 sulfur compounds contained in gelatin, various sulfur compounds such as thiosulfates, thioureas, thiazoles and rhodanines, among which thiosulfates and thioureas are preferred. As the thiourea compounds, the specifically tetra-substituted thiourea compounds described in U.S. Patent No. 4,810,626 are 10 particularly preferred. Although the amount of the sulfur sensitizer to be added varies depending on various conditions such as pH, temperature and grain size of silver halide at the time of chemical ripening, it is preferably  $10^{-7}$  to  $10^{-2}$  mol, more preferably  $10^{-5}$  to  $10^{-3}$  mol, per mol of silver halide.

15 As the selenium sensitizer used for the present invention, a known selenium compound may be used. That is, the selenium sensitization is usually performed by adding a labile and/or non-labile selenium compound and stirring the emulsion at a high temperature of 40°C or above for a predetermined time. As 20 the labile selenium compound, those compounds described in JP-B-44-15748, JP-B-43-13489, JP-A-4-109240 and JP-A-4-324855 can be used. Among these, particularly preferred are those compounds represented by formulas (VIII) and (IX) mentioned in JP-A-4-324855.

25 The tellurium sensitizer used for the present invention is a compound capable of producing silver telluride, presumably serves as a sensitization nucleus, on surfaces or inside of

silver halide grains. The rate of the formation of silver telluride in a silver halide emulsion can be examined according to the method described in JP-A-5-313284.

Specific examples of the tellurium sensitizer that can be used include the compounds described in U.S. Patent Nos. 5 1,623,499, 3,320,069 and 3,772,031; British Patents Nos. 235,211, 1,121,496, 1,295,462 and 1,396,696; Canadian Patent No. 800,958; JP-A-4-204640, JP-A-4-271341, JP-A-4-333043, JP-A-5-303157; J. Chem. Soc. Chem. Commun., 635 (1980); ibid., 1102 10 (1979); ibid., 645 (1979); J. Chem. Soc. Perkin. Trans., 1, 2191 (1980); S. Patai (compiler), The Chemistry of Organic Selenium and Tellurium Compounds, Vol. 1 (1986); and ibid., Vol. 2 (1987). The compounds represented by the formulas (II), (III) and (IV) mentioned in JP-A-4-324855 are particularly preferred.

15 The amount of the selenium or tellurium sensitizer used for the present invention varies depending on silver halide grains used, chemical ripening conditions etc. However, it is generally about  $10^{-8}$  to about  $10^{-2}$  mol, preferably about  $10^{-7}$  to about  $10^{-3}$  mol, per mol of silver halide. The conditions for 20 chemical sensitization in the present invention are not particularly restricted. However, in general, pH is 5 to 8, pAg is 6 to 11, preferably 7 to 10, and temperature is 40 to 95°C, preferably 45 to 85°C.

Noble metal sensitizers that can be used for the present 25 invention include gold, platinum, palladium, iridium etc., and gold sensitization is particularly preferred. Specific examples of the gold sensitizers used for the present invention include

chloroauric acid, potassium chloroaurate, potassium aurithiocyanate, gold sulfide and so forth, which can be used in an amount of about  $10^{-7}$  to about  $10^{-2}$  mol per mol of silver halide.

5 As for the silver halide emulsion used for the present invention, production or physical ripening process for the silver halide grains may be performed in the presence of a cadmium salt, sulfite, lead salt, thallium salt or the like.

10 In the present invention, reduction sensitization may be used. Examples of the reduction sensitizer include stannous salts, amines, formamidinesulfinic acid, silane compounds and so forth.

15 To the silver halide emulsion used in the present invention, a thiosulfonic acid compound may be added according to the method described in European Patent Publication EP293917A.

20 In the silver halide photographic light-sensitive material of the present invention, 1 to 3 kinds of silver halide emulsions are preferably used in combination. When two or more kinds of silver halide emulsions are used, those different in average grain sizes, halogen compositions, kinds or contents of contained metal complexes, crystal habits, chemical sensitization conditions or sensitivities may be used in combination. In order to obtain high contrast, in particular, 25 it is preferable to provide an emulsion layer having higher sensitivity as it becomes closer to a support as described in JP-A-6-324426.

Coated silver amount in the silver halide photographic light-sensitive material of the present invention is preferably 3.0 g/m<sup>2</sup> or less, more preferably 2.0 to 3.0 g/m<sup>2</sup>.

Examples of the support used for the silver halide photographic light-sensitive material of the present invention include, for example, baryta paper, polyethylene-laminated paper, polypropylene synthetic paper, glass plate, cellulose acetate, cellulose nitrate, polyester film such as polyethylene terephthalate film, supports comprising a styrene polymer having syndiotactic structure described in JP-A-7-234478 and U.S. Patent No. 5,558,979, and supports comprising a polyester film coated with a vinylidene chloride copolymer described in JP-A-64-538, U.S. Patent Nos. 4,645,731, 4,933,267 and 4,954,430. These supports are suitably selected depending on purpose of use of the silver halide photographic light-sensitive material.

As a binder for the silver halide emulsion layer and other hydrophilic colloid layers constituting the silver halide photographic light-sensitive material of the present invention, gelatin is preferably used, but it is also possible to use the polymer described in JP-A-10-268464, paragraph 0025. The amount of the binder present in the whole hydrophilic colloid layers on the side having the silver halide emulsion layer is 3 g/m<sup>2</sup> or less (preferably 1.0 to 3.0 g/m<sup>2</sup>), and the total amount of the binder present in the whole hydrophilic colloid layers on the side having the silver halide emulsion layer and the whole hydrophilic colloid layers on the opposite side is 7.0 g/m<sup>2</sup> or

less, preferably 2.0 to 7.0 g/m<sup>2</sup>.

In the present invention, in order to control the surface roughness of the outermost layers of the silver halide photographic light-sensitive material, inorganic and/or organic 5 polymer fine powder particles (hereinafter, called a matting agent) are preferably used in a hydrophilic colloid layer. The surface roughness of the outermost layer on the side having the silver halide emulsion layer of the light-sensitive material and the surface roughness of the outermost layer on the 10 opposite side can be controlled by variously changing the average particle size and amount of the matting agent. The layer to which the matting agent is added can be any of the layers constituting the light-sensitive material. However, with respect to the side having the silver halide emulsion layer, it 15 is preferable to add it to a layer positioned remoter from the support in order to prevent pinholes, and the outermost layer is particularly preferred.

The matting agent used in the present invention can be of any type of solid particles so long as it does not adversely 20 affect the various photographic characteristics. Specific examples include those described in JP-A-10-268464, paragraphs 0009 to 0013.

The average particle size of the matting agent used in the present invention is preferably in the range of 20  $\mu\text{m}$  or 25 less, particularly preferably 1 to 10  $\mu\text{m}$ . In the present invention, the amount of matting agent is preferably 5 to 400 mg/m<sup>2</sup>, particularly preferably 10 to 200 mg/m<sup>2</sup>.

As for the surface roughness of the silver halide photographic light-sensitive material of the present invention, at least one of the outermost surfaces of the side having the emulsion layer and the opposite side, preferably the both surfaces, have a Beck's smoothness of 4000 seconds or less, preferably 10 to 4000 seconds. The Beck's smoothness can be easily determined in accordance with Japanese Industrial Standard (JIS) P8119 and TAPPI Standard Method T479.

In the present invention, in order to improve settling of the matting agent during coating and drying of the silver halide photographic light-sensitive material and improve pressure-induced sensitivity fluctuation, curl balance, abrasion resistance and adhesion resistance during automatic transportation, exposure, development etc., colloidal inorganic particles can be used in the silver halide emulsion layer, intermediate layer, protective layer, back layer, back protective layer etc. Preferred examples of the colloidal inorganic particles include silica particles of elongated shape described in JP-A-10-268464, paragraphs 0008 and 0014, colloidal silica, the pearl-like (pearl necklace form) colloidal silica "Snowtex PS" manufactured by Nissan Chemical Industries, Ltd. and so forth.

The amount of colloidal inorganic particles used in the present invention is 0.01 to 2.0, preferably 0.1 to 0.6, in terms of a ratio based on dry weight relative to the binder (e.g. gelatin) in the layer to which they are added.

In the present invention, in order to improve the

pressure-induced sensitivity fluctuation etc., the polyhydroxybenzene compounds described in JP-A-3-39948, page 10, lower right column, line 11 to page 12, lower left column, line 5 are preferably used. More specifically, Compounds (III)-1 to 5 (III)-25 described in the same can be mentioned.

In the present invention, in order to improve brittleness, dimensional stability, pressure-induced sensitivity fluctuation etc., polymer latex can be used. Examples of the polymer latex include polymer latexes formed from various types of monomers 10 such as an alkyl acrylate and an alkyl methacrylate described in U.S. Patent Nos. 2,763,652, 2,852,382, JP-A-64-538, JP-A-62-115152, JP-A-5-66512, JP-A-5-80449, JP-B-60-15935, 6-64058, 5-45014 etc., polymer latexes formed by copolymerizing a monomer having an active methylene group and a monomer such as an alkyl 15 acrylate described in JP-B-45-5819, JP-B-46-22507, JP-A-50-73625, JP-A-7-152112, JP-A-8-137060 etc., and so forth.

Particularly preferred are polymer latexes having a core/shell structure, in which the shell portion contains a repeating unit comprising an ethylenically unsaturated monomer having an 20 active methylene group described in JP-A-8-248548, JP-A-8-208767, JP-A-8-220669 etc. These core/shell structure polymer latexes having an active methylene group in the shell portion can improve properties including brittleness, dimensional 25 stability, adhesion resistance between the light-sensitive materials and so forth without degrading the wet film strength of the photographic light-sensitive material, and the latexes themselves have improved shear stability.

The amount of polymer latex is 0.01 to 4.0, preferably 0.1 to 2.0, in terms of a ratio based on dry weight relative to the binder (e.g., gelatin) in the layer to which the latex is added.

5        In the present invention, in order to decrease pH of the coated film for the purpose of improving storage stability, pressure-induced sensitivity fluctuation etc. of the silver halide photographic light-sensitive material, the acidic polymer latex described in JP-A-7-104413, page 14, left column, 10 line 1 to right column, line 30 is preferably used. More specifically, Compounds II-1) to II-9) described on page 15 of the same and the compounds having an acid group described in JP-A-2-103536, page 18, lower right column, line 6 to page 19, upper left column, line 1 are preferably used.

15      pH of the coated film on the side having the silver halide emulsion layer is preferably 6 to 4.

At least one of the layers constituting the silver halide photographic light-sensitive material of the present invention can be a conductive layer having a surface resistivity of  $10^{12} \Omega$  20 or less in an atmosphere of 25°C and 25% relative humidity.

Examples of the conductive material used in the present invention include the conductive materials described in JP-A-2-18542, page 2, lower left column, line 13 to page 3, upper right column, line 7, more specifically, the metal oxides described on page 2, lower right column, line 2 to line 10 of the same, and conductive macromolecular compounds of P-1 to P-7 described in the same, acicular metal oxides described in U.S.

Patent No. 5,575,957, JP-A-10-142738, paragraphs 0034 to 0043, JP-A-11-23901, paragraphs 0013 to 0019 and so forth.

In the present invention, in addition to the aforementioned conductive materials, the fluorine-containing surfactants described in JP-A-2-18542, page 4, upper right column, line 2 to page 4, lower right column, line 3 from the bottom, and JP-A-3-39948, page 12, lower left column, line 6 to page 13, lower right column, line 5 can be used together to further improve the antistatic property.

In the present invention, the silver halide emulsion layer or other hydrophilic colloid layers can contain a coating aid, dispersing and solubilizing agent for additives and various types of surfactants for the purposes of improvement of lubrication, prevention of adhesion, improvement of photographic characteristics (for example, acceleration of development, impartation of higher contrast, sensitization, storage stability) etc. For example, the surfactants described in JP-A-2-12236, page 9, upper right column, line 7 to lower right column, line 3, PEG type surfactants described in JP-A-2-103536, page 18, lower left column, lines 4 to 7, more specifically, Compounds VI-1 to VI-15 described in the same, and fluorine-containing surfactants described in JP-A-2-18542, page 4, upper right column, line 2 to lower right column, line 3 from the bottom and JP-A-3-39948, page 12, lower left column, line 6 to page 13, lower right column, line 5 can be mentioned.

In the present invention, various types of lubricants can be used in order to improve transportation property in an

automatic transportation apparatus, abrasion resistance, pressure-induced sensitivity fluctuation etc. of the silver halide photographic light-sensitive material. For example, the lubricants described in JP-A-2-103536, page 19, upper left 5 column, line 15 to upper right column, line 15 and JP-A-4-214551, paragraphs 0006 to 0031 can be used.

In the present invention, as a plasticizer for coated films of the silver halide photographic light-sensitive material, the compounds described in JP-A-2-103536, page 19, 10 upper left column, line 12 to upper right column, line 15 can be used.

In the present invention, as a crosslinking agent for the hydrophilic binders, the compounds described in JP-A-2-103536, page 18, upper right column, line 5 to line 17 and JP-A-5-15 297508, paragraphs 0008 to 0011 can be used.

The swelling ratio of the hydrophilic colloid layers including the emulsion layers and protective layers of the silver halide photographic light-sensitive material of the present invention is preferably in the range of 50 to 200%, 20 more preferably 70 to 180%. The swelling ratio of the hydrophilic colloid layer can be determined in the following manner. The thickness ( $d_0$ ) of the hydrophilic colloid layers including the emulsion layers and protective layers of the silver halide photographic light-sensitive material is measured 25 and the swollen thickness ( $\Delta d$ ) is measured after the silver halide photographic material is immersed in distilled water at 25°C for one minute. Then, the swelling ratio is calculated

from the following equation: Swelling ratio (%) =  $(\Delta d/d_0) \times 100$ .

Environment, processing, heat treatment and so forth of the silver halide photographic light-sensitive material of the present invention during drying after coating and rolling up

5 the material into a roll after drying are preferably determined or performed according to the descriptions of JP-A-10-268464, paragraphs 0026 to 0032.

The light-sensitive material of the present invention is preferably subjected to a heat treatment at any time after

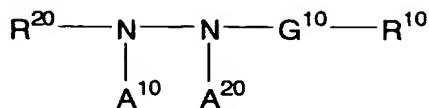
10 coating and before development. Although the heat treatment can be successively carried out immediately after coating or carried out after a certain period of time has passed, it is preferably carried out after a short period of time, for example, within 1 day. The heat treatment is carried out mainly

15 in order to promote film hardening reaction so as to obtain film strength sufficient to withstand development. The heat treatment conditions should be appropriately determined depending on the type of hardening agent, amount thereof, pH of the film, required film strength etc. The heat treatment is

20 preferably carried out at 30 to 60°C, more preferably 35 to 50°C. The term for the heat treatment is preferably for 30 minutes to 10 days.

The silver halide photographic light-sensitive material of the present invention preferably contains a hydrazine compound as a nucleating agent. It particularly preferably contains at least one kind of compound represented by the formula (D).

Formula (D)



In the formula,  $R^{20}$  represents an aliphatic group, an  
5 aromatic group or a heterocyclic group,  $R^{10}$  represents hydrogen  
atom or a blocking group, and  $G^{10}$  represents  $-CO-$ ,  $-COCO-$ ,  $-$   
 $C(=S)-$ ,  $-SO_2-$ ,  $-SO-$ ,  $-PO(R^{30})-$  group ( $R^{30}$  is selected from the  
same range of groups defined for  $R^{10}$ , and  $R^{30}$  may be different  
10 from  $R^{10}$ ) or an iminomethylene group.  $A^{10}$  and  $A^{20}$  both represent  
 $10$  hydrogen atom, or one of them represents hydrogen atom and the  
other represents a substituted or unsubstituted alkylsulfonyl  
group, a substituted or unsubstituted arylsulfonyl group or a  
substituted or unsubstituted acyl group.

In the formula (D), the aliphatic group represented by  $R^{20}$   
15 is preferably a substituted or unsubstituted straight, branched  
or cyclic alkyl, alkenyl or alkynyl group having 1 to 30 carbon  
atoms.

In the formula (D), the aromatic group represented by  $R^{20}$   
is a monocyclic or condensed-ring aryl group. Examples of the  
20 ring include benzene ring and naphthalene ring. The  
heterocyclic group represented by  $R^{20}$  is a monocyclic or  
condensed-ring, saturated or unsaturated, aromatic or non-  
aromatic heterocyclic group. Examples of the ring include  
pyridine ring, pyrimidine ring, imidazole ring, pyrazole ring,

quinoline ring, isoquinoline ring, benzimidazole ring, thiazole ring, benzothiazole ring, piperidine ring, triazine ring and so forth.

5       $R^{20}$  is preferably an aryl group, especially preferably a phenyl group.

The group represented by  $R^{20}$  may be substituted with a substituent. Typical examples of the substituent include, for example, a halogen atom (fluorine atom, chlorine atom, bromine atom or iodine atom), an alkyl group (including an aralkyl 10 group, a cycloalkyl group, an active methine group etc.), an alkenyl group, an alkynyl group, an aryl group, a heterocyclic group, a quaternized nitrogen atom-containing heterocyclic group (e.g., pyridinio group), an acyl group, an alkoxy carbonyl group, an aryloxy carbonyl group, a carbamoyl group, carboxyl 15 group or a salt thereof, a sulfonyl carbamoyl group, an acyl carbamoyl group, a sulfamoyl carbamoyl group, a carbazoyl group, an oxanyl group, an oxamoyl group, cyano group, a thiocarbamoyl group, hydroxy group, an alkoxy group (including a group containing a repeating unit of ethyleneoxy group or 20 propyleneoxy group), an aryloxy group, a heterocyclyloxy group, an acyloxy group, an (alkoxy or aryloxy) carbonyloxy group, a carbamoyloxy group, a sulfonyloxy group, amino group, an (alkyl, aryl or heterocyclyl) amino group, an N-substituted nitrogen-containing heterocyclic group, an acylamino group, a 25 sulfonamido group, a ureido group, a thioureido group, an isothioureido group, an imido group, an (alkoxy or aryloxy) carbonylamino group, a sulfamoylamino group, a

semicarbazido group, a thiosemicarbazido group, a hydrazino group, a quaternary ammonio group, an oxamoylamino group, an (alkyl or aryl)sulfonylureido group, an acylureido group, an N-acylsulfamoylamino group, nitro group, mercapto group, an 5 (alkyl, aryl or heterocyclyl)thio group, an (alkyl or aryl)sulfonyl group, an (alkyl or aryl)sulfinyl group, sulfo group or a salt thereof, a sulfamoyl group, an N-acylsulfamoyl group, a sulfonylsulfamoyl group or a salt thereof, a group having phosphoric acid amide or phosphoric acid ester structure 10 and so forth.

These substituents may be further substituted with any of these substituents.

Preferred examples of the substituent that R<sup>20</sup> may have include an alkyl group having 1 to 30 carbon atoms (including 15 an active methylene group), an aralkyl group, a heterocyclic group, a substituted amino group, an acylamino group, a sulfonamido group, a ureido group, a sulfamoylamino group, an imido group, a thioureido group, a phosphoric acid amido group, hydroxyl group, an alkoxy group, an aryloxy group, an acyloxy 20 group, an acyl group, an alkoxy carbonyl group, an aryloxy carbonyl group, a carbamoyl group, carboxyl group or a salt thereof, an (alkyl, aryl or heterocyclyl)thio group, sulfo group or a salt thereof, a sulfamoyl group, a halogen atom, cyano group, nitro group and so forth.

25 In the formula (D), R<sup>10</sup> represents hydrogen atom or a blocking group, and specific examples of the blocking group include an alkyl group, an alkenyl group, an alkynyl group, an

aryl group, a heterocyclic group, an alkoxy group, an aryloxy group, an amino group and a hydrazino group.

The alkyl group represented by  $R^{10}$  is preferably an alkyl group having 1 to 10 carbon atoms. Examples of the alkyl group include methyl group, trifluoromethyl group, difluoromethyl group, 2-carboxytetrafluoroethyl group, pyridiniomethyl group, difluoromethoxymethyl group, difluorocarboxymethyl group, 3-hydroxypropyl group, methanesulfonamidomethyl group, benzenesulfonamidomethyl group, hydroxymethyl group, methoxymethyl group, methylthiomethyl group, phenylsulfonylmethyl group, o-hydroxybenzyl group and so forth.

The alkenyl group is preferably an alkenyl group having 1 to 10 carbon atoms. Examples of the alkenyl group include vinyl group, 2,2-dicyanovinyl group, 2-ethoxycarbonylvinyl group, 2-trifluoro-2-methoxycarbonylvinyl group and so forth. The alkynyl group is preferably an alkynyl group having 1 to 10 carbon atoms. Examples of the alkynyl group include ethynyl group, 2-methoxycarbonyl ethynyl group and so forth. The aryl group is preferably a monocyclic or condensed-ring aryl group, and especially preferably an aryl group containing a benzene ring. Examples of the aryl group include phenyl group, 3,5-dichlorophenyl group, 2-methanesulfonamidophenyl group, 2-carbamoylphenyl group, 4-cyanophenyl group, 2-hydroxymethylphenyl group and so forth.

The heterocyclic group is preferably a 5- or 6-membered, saturated or unsaturated, monocyclic or condensed-ring heterocyclic group containing at least one nitrogen, oxygen or

sulfur atom, and it may be a heterocyclic group containing a quaternized nitrogen atom. Examples of the heterocyclic group include a morpholino group, a piperidino group (N-substituted), a piperazino group, an imidazolyl group, an indazolyl group  
5 (e.g., 4-nitroindazolyl group etc.), a pyrazolyl group, a triazolyl group, a benzimidazolyl group, a tetrazolyl group, a pyridyl group, a pyridinio group (e.g., N-methyl-3-pyridinio group), a quinolinio group, a quinolyl group and so forth.  
Among these, especially preferred are a morpholino group, a  
10 piperidino group, a pyridyl group, a pyridinio group and so forth.

The alkoxy group is preferably an alkoxy group having 1 to 8 carbon atoms. Examples of the alkoxy group include methoxy group, 2-hydroxyethoxy group, benzyloxy group and so forth. The  
15 aryloxy group is preferably a phenoxy group. The amino group is preferably unsubstituted amino group, an alkylamino group having 1 to 10 carbon atoms, an arylamino group or a saturated or unsaturated heterocyclylamino group (including a quaternized nitrogen atom-containing heterocyclic group). Examples of the  
20 amino group include 2,2,6,6-tetramethylpiperidin-4-ylamino group, propylamino group, 2-hydroxyethylamino group, anilino group, o-hydroxyanilino group, 5-benzotriazolylamino group, N-benzyl-3-pyridinioamino group and so forth. The hydrazino group is especially preferably a substituted or unsubstituted  
25 hydrazino group, a substituted or unsubstituted phenylhydrazino group (e.g., 4-benzenesulfonamidophenylhydrazino group) or the like.

The group represented by  $R^{10}$  may be substituted with a substituent. Preferred examples of the substituent are the same as those exemplified as the substituent of  $R^{20}$ .

In the formula (D),  $R^{10}$  may be a group capable of splitting the  $G^{10}-R^{10}$  moiety from the residual molecule and subsequently causing a cyclization reaction that produces a cyclic structure containing atoms of the  $-G^{10}-R^{10}$  moiety. Examples of such a group include those described in, for example, JP-A-63-29751.

The hydrazine derivatives represented by the formula (D) may contain an absorptive group capable of being absorbed onto silver halide. Examples of the absorptive group include an alkylthio group, an arylthio group, a thiourea group, a thioamido group, a mercaptoheterocyclic group, a triazole group and so forth, described in U.S. Patent Nos. 4,385,108, 4,459,347, JP-A-59-195233, JP-A-59-200231, JP-A-59-201045, JP-A-59-201046, JP-A-59-201047, JP-A-59-201048, JP-A-59-201049, JP-A-61-170733, JP-A-61-270744, JP-A-62-948, JP-A-63-234244, JP-A-63-234245 and JP-A-63-234246. Further, these groups capable of being absorbed onto silver halide may be modified into a precursor thereof. Examples of the precursor include those groups described in JP-A-2-285344.

$R^{10}$  or  $R^{20}$  in the formula (D) may contain a ballast group or polymer that is usually used for immobile photographic additives such as couplers. The ballast group used in the present invention means a group having 6 or more carbon atoms including such a linear or branched alkyl group (or an alkylene

group), an alkoxy group (or an alkyleneoxy group), an alkylamino group (or an alkyleneamino group), an alkylthio group or a group having any of these groups as a partial structure, more preferably a group having 7 to 24 carbon atoms 5 including such a linear or branched alkyl group (or an alkylene group), an alkoxy group (or an alkyleneoxy group), an alkylamino group (or an alkyleneamino group), an alkylthio group or a group having any of these groups as a partial structure. Examples of the polymer include those described in, 10 for example, JP-A-1-100530.

$R^{10}$  or  $R^{20}$  in the formula (D) may contain a plurality of hydrazino groups as substituents. In such a case, the compound represented by the formula (D) is a multimer for hydrazino group. Specific examples of such a compound include those 15 described in, for example, JP-A-64-86134, JP-A-4-16938, JP-A-5-197091, WO95/32452, WO95/32453, JP-A-9-179229, JP-A-9-235264, JP-A-9-235265, JP-A-9-235266, JP-A-9-235267 and so forth.

$R^{10}$  or  $R^{20}$  in the formula (D) may contain a cationic group (specifically, a group containing a quaternary ammonio group, a 20 group containing a quaternized phosphorus atom, a nitrogen-containing heterocyclic group containing a quaternized nitrogen atom etc.), a group containing repeating units of ethyleneoxy group or propyleneoxy group, an (alkyl, aryl or heterocyclyl)thio group, or a dissociating group (this means a 25 group or partial structure having a proton of low acidity that can be dissociated with an alkaline developer or a salt thereof, specifically, for example, carboxyl group (-COOH), sulfo group

(-SO<sub>3</sub>H), phosphonic acid group (-PO<sub>3</sub>H), phosphoric acid group (-OPO<sub>3</sub>H), hydroxy group (-OH), mercapto group (-SH), -SO<sub>2</sub>NH<sub>2</sub> group, N-substituted sulfonamido group (-SO<sub>2</sub>NH-, -CONHSO<sub>2</sub>- group, -CONHSO<sub>2</sub>NH- group, -NHCONHSO<sub>2</sub>- group, -SO<sub>2</sub>NHSO<sub>2</sub>- group), -CONHCO- group, active methylene group, -NH- group contained in a nitrogen-containing heterocyclic group, salts thereof etc.).  
5 Examples of the compounds containing these groups include those described in, for example, JP-A-7-234471, JP-A-5-333466, JP-A-6-19032, JP-A-6-19031, JP-A-5-45761, U.S. Patent Nos. 4,994,365, 10 4,988,604, JP-A-7-259240, JP-A-7-5610, JP-A-7-244348, German Patent No. 4006032, JP-A-11-7093 and so forth.

In the formula (D), A<sup>10</sup> and A<sup>20</sup> each represent hydrogen atom or an alkyl- or arylsulfonyl group having 20 or less carbon atoms (preferably, phenylsulfonyl group or a phenylsulfonyl group substituted with substituent(s) so that the total of the Hammett's substituent constant of the substituent(s) should become -0.5 or more), or an acyl group having 20 or less carbon atoms (preferably, benzoyl group, a benzoyl group substituted with substituent(s) so that the total 15 of the Hammett's substituent constant of the substituent(s) should become -0.5 or more, or a straight, branched or cyclic, substituted or unsubstituted, aliphatic acyl group (examples of the substituent include a halogen atom, an ether group, a sulfonamido group, a carbonamido group, hydroxyl group, 20 carboxyl group, sulfo group etc.)). A<sup>10</sup> and A<sup>20</sup> each most preferably represent hydrogen atom.

Hereafter, hydrazine derivatives especially preferably

used for the present invention are explained.

$R^{20}$  is especially preferably a substituted phenyl group. Particularly preferred as the substituent are an alkyl group, an (alkyl, aryl or heterocyclyl)oxy group, an (alkyl, aryl or heterocyclyl)thio group, a sulfonamido group, an acylamino group, a ureido group, a carbamoyl group, a thioureido group, an isothioureido group, a sulfamoylamino group, an N-acylsulfamoylamino group and so forth, further preferred are an alkyl group, an (alkyl, aryl or heterocyclyl)oxy group, an (alkyl, aryl or heterocyclyl)thio group, an acylamino group, a sulfonamido group and a ureido group, and the most preferred are an alkyl group and a sulfonamido group.

The hydrazine derivatives represented by the formula (D) preferably have at least one substituent, directly or indirectly on  $R^{20}$  or  $R^{10}$ , selected from the group consisting of a ballast group, a group that can be absorbed on silver halide, a group containing quaternary ammonio group, a nitrogen-containing heterocyclic group containing a quaternized nitrogen atom, a group containing repeating units of ethyleneoxy group, an (alkyl, aryl or heterocyclyl)thio group, a dissociating group capable of dissociating in an alkaline developer, and a hydrazino group capable of forming a multimer (group represented by  $-NHNH-G^{10}-R^{10}$ ). Furthermore,  $R^{20}$  preferably directly or indirectly has one group selected from the aforementioned groups as a substituent, and  $R^{20}$  most preferably represents a phenyl group substituted with an alkyl group or a benzenesulfonamido group directly or indirectly having one of

the aforementioned groups as a substituent on the benzene ring of the benzenesulfonamido group.

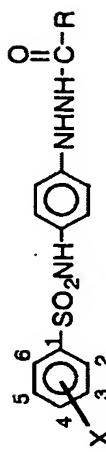
Among those groups represented by  $R^{10}$ , when  $G^{10}$  is -CO-group, preferred are hydrogen atom, an alkyl group, an alkenyl group, an alkynyl group, an aryl group and a heterocyclic group, more preferred are hydrogen atom, an alkyl group and a substituted aryl group (the substituent is especially preferably an electron-withdrawing group or o-hydroxymethyl group), and the most preferred are hydrogen atom and an alkyl group.

When  $G^{10}$  is -COCO- group, an alkoxy group, an aryloxy group, and an amino group are preferred, and a substituted amino group, specifically an alkylamino group, an arylamino group and a saturated or unsaturated heterocyclamino group are especially preferred.

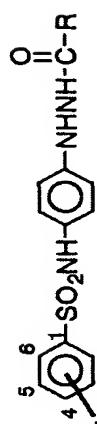
Further, when  $G^{10}$  is  $-SO_2-$  group,  $R^{10}$  is preferably an alkyl group, an aryl group or a substituted amino group.

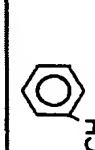
In the formula (D),  $G^{10}$  is preferably -CO- group or -COCO-group, especially preferably -CO- group.

Specific examples of the compounds represented by the formula (D) are illustrated below. However, the compounds represented by the formula (D) that can be used for the present invention are not limited to the following compounds. In the present specification, "Mw" means average molecular weight.



$X =$	R =	-H	$-\text{C}_2\text{F}_4\text{ COOH}$ (or $-\text{C}_2\text{F}_4\text{ COO}^{\oplus}\text{ K}^{\oplus}$ )	$-\text{C}_6\text{H}_5\text{ CH}_2\text{OH}$	$-\text{CONH-C}_6\text{H}_5$
D-1 $3-\text{NHCOCH}_2\text{H}_1\text{B}(\text{n})$	1a	1b		1c	1d
D-2 $3-\text{NHCONH} \sim \text{S-C}_7\text{H}_{15}\text{B}(\text{n})$	2a	2b		2c	2d
D-3 $3-\text{NHCOCH}_2\text{N}^{\oplus}\text{C}_6\text{H}_4\text{N}^{\ominus}$	3a	3b		3c	3d
D-4 $3-\text{NHCOCH}_2\text{N}^{\oplus}\text{C}_8\text{H}_{17}$ $\text{Cl}^{\ominus}$	4a	4b		4c	4d
D-5 $3-\text{NHCO-C}_6\text{H}_4\text{N}^{\oplus}\text{H}^{\ominus}$	5a	5b		5c	5d
D-6 $3-\text{NHCONH-C}_6\text{H}_4\text{N}^{\oplus}\text{N}^{\ominus}$	6a	6b		6c	6d
D-7 $2,4-(\text{CH}_3)_2\text{C}_2\text{H}_4\{(\text{OC}_2\text{H}_4)_4\text{OC}_8\text{H}_{17}$	7a	7b		7c	7d

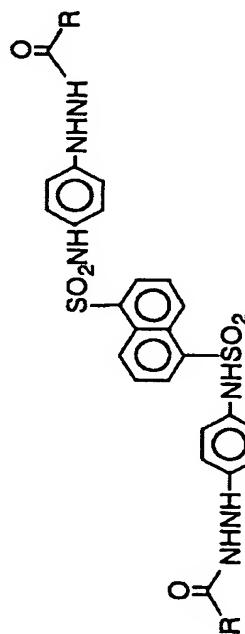
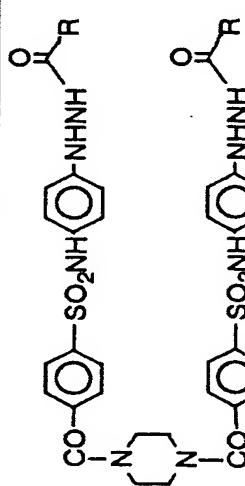
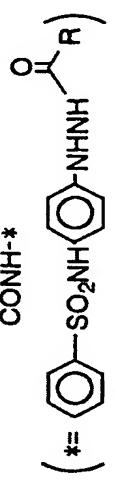


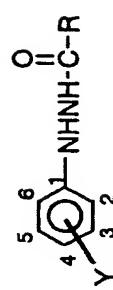
	$R =$	$X =$	$-H$	$-CF_2H$	$-CH_2-N^+_{\text{cyclic}}(Cl^-)$	$-CONH-\text{cyclic}-NH$
D-8	$C_2H_5$	$3-\text{CONHCH}_2\text{CH-C}_4\text{H}_9$	8a	8e	8f	8g
D-9	$6-\text{OCH}_3-3-\text{C}_5\text{H}_11(t)$		9a	9e	9f	9g
D-10	$3-\text{SH}$	$3-\text{N}(\text{N}_2\text{N})$	10a	10e	10f	10g
D-11	$3-\text{NHCOCH}_2\text{SCH}_2$		11a	11e	11f	11g
D-12	$4-\text{NHCOCH}_2-\text{S}-\text{C}_6\text{H}_4-\text{S}-\text{NHCOCH}_2$		12a	12e	12f	12g
D-13	$3-\text{NHCOCH}_2\text{C}_8\text{H}_{17}$	$\text{CH}_2\text{COOH}$	13a	13e	13f	13g
D-14	$C_2H_5$	$3,5-\text{(CONHCH}_2\text{CH-C}_4\text{H}_9)_2$	14a	14e	14f	14g



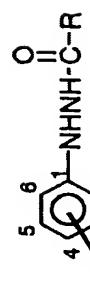
	$Y =$	$X =$	$-CHO$	$-OCF_3$	$-SO_2CH_3$	$-\overset{\overset{\text{O}}{\parallel}}{\text{P}}(\text{OC}_2\text{H}_5)_2$
D-15	$3-\text{NHCOCH}_2\overset{\oplus}{\text{N}}(\text{C}_6\text{H}_4\text{Cl})\ominus$	15a		15h	15i	15j
D-16	$4-\text{NHCO}(\text{CH}_2)_2\overset{\oplus}{\text{N}}\text{C}_6\text{H}_{13}\text{Cl}^\ominus$	16a		16h	16i	16j
D-17	$3-\text{SO}_2\text{NH}-\text{CH}_2-\text{CH}_2-\text{O}-\text{CH}_2-\text{CH}_2-\text{OC}_4\text{H}_9$	17a		17h	17i	17j
D-18	$\text{CH}_3-\text{CH}_2-\text{COOC}_4\text{H}_9$	18a		18h	18i	18j
D-19	$3-\text{NHCO}-\text{CH}_2-\text{CH}_2-\text{S}-\text{S}-\text{CH}_2-\text{CH}_2-\text{NHCO}_3$	19a		19h	19i	19j
D-20	$3-\text{NHSO}_2\text{NH-C}_8\text{H}_{17}$	20a		20h	20i	20j
D-21	$2-\text{Cl}-5-\text{N}(\text{SH})\text{N}=\text{N}$	21a		21h	21i	21j

	R =	-H	-CF <sub>2</sub> H	-CH <sub>2</sub> -Cl	-CONHCH <sub>3</sub> H <sub>7</sub>
D-22		22a	22e	22k	22l
D-23		23a	23e	23k	23l
D-24		24a	24e	24k	24l
D-25		25a	25e	25k	25l

	R=	-H	-CF <sub>3</sub> H	-CH <sub>2</sub> -  -Cl	-CONHC <sub>3</sub> H <sub>7</sub>
D-26		26a	26e	26k	26l
D-27		27a	27e	27k	27l
D-28	*-NHCO-  -CONH-* (*:=  <td>28a</td> <td>28e</td> <td>28k</td> <td>28l</td>	28a	28e	28k	28l



	$\gamma =$	R =				
D-29	$\begin{array}{c} S \\    \\ 4-\text{NHCONH-C}_8\text{H}_{17}(\text{H}) \end{array}$	-H	$-\text{CH}_2\text{OCH}_3$	$\begin{array}{c} \text{O} \\ \text{C} \\ \text{O} \\   \\ \text{NHC} \\   \\ \text{C}_6\text{H}_4 \\   \\ \text{HN-N} \end{array}$	$-\text{CH}_2\text{N}(\text{C}_6\text{H}_4\text{Cl})\text{Cl}^\ominus$	29f
D-30	$\begin{array}{c} S \\    \\ 4-\text{NHR} \\   \\ \text{OCH}_2\text{C}_6\text{H}_4 \end{array} \Big)_2$	29a	29m	29n		
D-31	$4-\text{NHCONH-(CH}_2)_3\text{O-C}_6\text{H}_4\text{CH}_3$	30a	30m	30n		30f
D-32	$\begin{array}{c} 4-\text{OH} \\   \\ \text{C}_2\text{H}_5 \\   \\ 3-\text{NHCONHCH}_2\text{CH-C}_4\text{H}_9 \end{array}$	31a	31m	31n		31f
D-33	$4-\text{NHSO}_2(\text{CH}_2)_2\text{NHCO-C}_6\text{H}_4\text{N}(\text{SH})\text{N}=\text{N}$	32a	32m	32n		32f
D-34	$4-\text{OCH}_2\text{C}_6\text{H}_4$	33a	33m	33n		33f
D-35	$4-\text{NHCONHN}\left(\text{CH}_2\text{C}_6\text{H}_4\right)_2$	34a	34m	34n		34f
		35a	35m	35n		35f



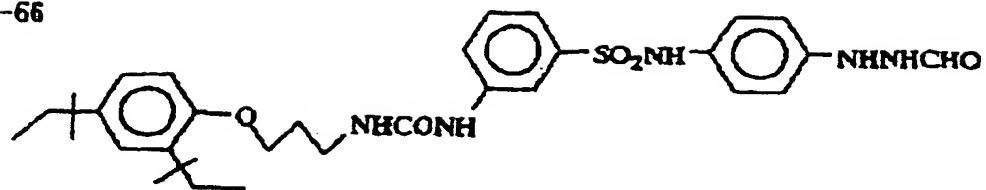
$\gamma =$	$R =$	$-H$	$-C_3F_4-COOH$	$-CONHCH_2$	$-C_6H_4-NO_2$
D-36	2- $NHSO_2CH_3^-$ 4- $NHC(=O)CH_2_3S(\text{H})$	36a	36o	36p	36q
D-37	2- $OCH_2^-$ 4- $NHSO_2C_{12}H_{25}$	37a	37o	37p	37q
D-38	2- $NHCOC_{11}H_{23}^-$ 4- $NHSO_2CF_3$	38a	38o	38p	38q
D-39		39a	39o	39p	39q
D-40	4- $OCO(CH_2)_2COOC_8H_{13}$	40a	40o	40p	40q
D-41		41a	41o	41p	41q
D-42		42a	42o	42p	42q

D-43	
D-44	
D-45	
D-46	
D-47	<p style="text-align: center;"><math>x:y=3:97</math> <math>M_w \approx 100,000</math></p>
D-48	
D-49	

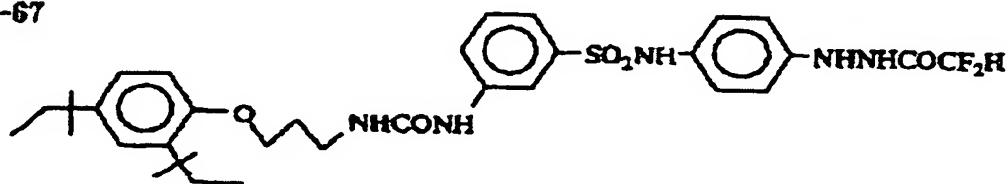
Na.	
D-50	
D-51	
D-52	
D-53	
D-54	
D-55	
D-56	
D-57	



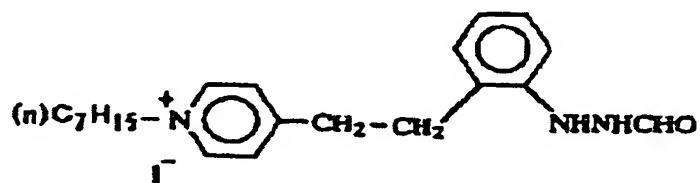
D-66



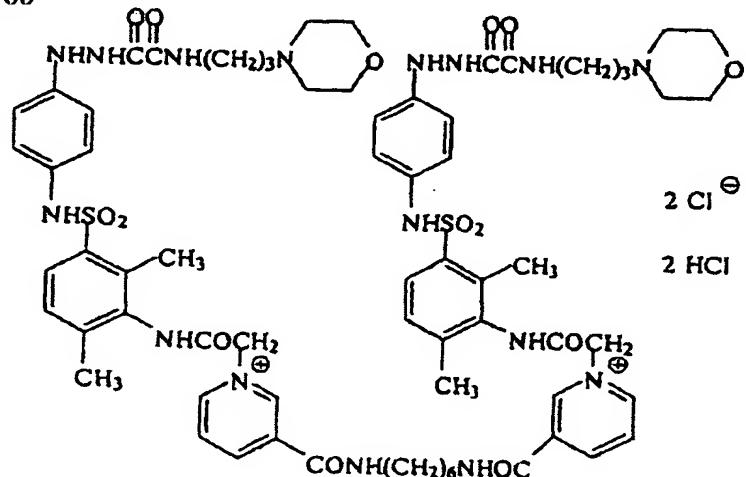
D-67



D-68



D-69



As the hydrazine derivatives used in the present invention, in addition to the above, the following hydrazine derivatives can also be preferably used. Further, the hydrazine derivatives used in the present invention can be synthesized by the various methods described in the patent documents mentioned

below.

That is, there are mentioned the compounds represented by (Chemical formula 1) described in JP-B-6-77138, specifically, compounds described on pages 3 and 4 of the same; compounds 5 represented by formula (I) described in JP-B-693082, specifically, Compounds 1 to 38 described on pages 8 to 18 of the same; compounds represented by formulas (4), (5), and (6) described in JP-A-6-230497, specifically, Compound 4-1 to Compound 4-10 described on pages 25 and 26, Compound 5-1 to 10 Compound 5-42 described on pages 28 to 36 and Compound 6-1 to Compound 6-7 described on pages 39 and 40 of the same, respectively; compounds represented by formulas (1) and (2) described in JP-A-6-289520, specifically, Compounds 1-1) to 1-17) and 2-1) described on pages 5 to 7 of the same; compounds 15 represented by (Chemical formula 2) and (Chemical formula 3) described in JP-A-6-313936, specifically, compounds described on pages 6 to 19 of the same; compounds represented by (Chemical formula 1) described in JP-A-6-313951, specifically, compounds described on pages 3 to 5 of the same; compounds 20 represented by formula (I) described in JP-A-7-5610, specifically, Compounds I-1 to I-38 described on pages 5 to 10 of the same; compounds represented by formula (II) described in JP-A-7-77783, specifically, Compounds II-1 to II-102 described on pages 10 to 27 of the same; compounds represented by 25 formulas (H) and (Ha) described in JP-A-7-104426, specifically, Compounds H-1 to H-44 described on pages 8 to 15 of the same; compounds that have an anionic group or nonionic group that

forms an intramolecular hydrogen bond with the hydrogen atom of the hydrazine in the vicinity of the hydrazine group described in JP-A-9-22082, especially compounds represented by formulas (A), (B), (C), (D), (E) and (F), specifically, Compounds N-1 to 5 N-30 described in the same; compounds represented by formula (1) described in JP-A-9-22082, specifically, Compounds D-1 to D-55 described in the same; the compounds represented by the formula (I) described in JP-A-10-232456, specifically Compounds N-I to N-XVIII described in the same; the compounds represented by the formula (I) described in JP-A-11-190887, specifically 10 Compounds N-I to N-XI described in the same; the compounds represented by the formula (I) described in JP-A-2001-109094, specifically Compounds II to X described in the same; the compounds represented by the formula (I) described in JP-A- 15 2001-100351, specifically Compounds II to XV described in the same; as well as the hydrazine derivatives described in WO95/32452, WO95/32453, JP-A-9-179229, JP-A-9-235264, JP-A-9- 235265, JP-A-9-235266, JP-A-9-235267, JP-A-9-319019, JP-A-9- 319020, JP-A-10-130275, JP-A-11-7093, JP-A-6-332096, JP-A-7- 20 209789, JP-A-8-6193, JP-A-8-248549, JP-A-8-248550, JP-A-8- 262609, JP-A-8-314044, JP-A-8-328184, JP-A-9-80667, JP-A-9- 127632, JP-A-9-146208, JP-A-9-160156, JP-A-10-161260, JP-A-10- 221800, JP-A-10-213871, JP-A-10-254082, JP-A-10-254088, JP-A-7- 120864, JP-A-7-244348, JP-A-7-333773, JP-A-8-36232, JP-A-8- 25 36233, JP-A-8-36234, JP-A-8-36235, JP-A-8-272022, JP-A-9-22083, JP-A-9-22084, JP-A-9-54381 and JP-A-10-175946.

In the present invention, the hydrazine nucleating agents

may be dissolved in an appropriate water-miscible organic solvent, such as an alcohol (e.g., methanol, ethanol, propanol, fluorinated alcohol), ketone (e.g., acetone, methyl ethyl ketone), dimethylformamide, dimethyl sulfoxide, methyl cellosolve or the like, before use.

5 The hydrazine nucleating agents may also be dissolved in an oil such as dibutyl phthalate, tricresyl phosphate, glyceryl triacetate or diethyl phthalate using an auxiliary solvent such as ethyl acetate or cyclohexanone and mechanically processed 10 into an emulsion dispersion by a conventionally well-known emulsion dispersion method before use. Alternatively, powder of hydrazine nucleating agents may be dispersed in water by means of ball mill, colloid mill or ultrasonic waves according to a method known as solid dispersion method and used.

15 In the present invention, the hydrazine nucleating agents may be added to any of a silver halide emulsion layer and other hydrophilic colloid layers on the silver halide emulsion layer side with respect to the support. However, it is preferably added to a silver halide emulsion layer or a hydrophilic 20 colloid layer adjacent thereto. Two or more kinds of hydrazine nucleating agents may be used in combination.

The addition amount of the nucleating agent in the present invention is preferably  $1 \times 10^{-4}$  mol or more, more preferably  $1 \times 10^{-4}$  to  $1 \times 10^{-2}$  mol, most preferably  $1 \times 10^{-4}$  to 25  $\times 10^{-3}$  mol, per mol of silver halide.

The silver halide photographic light-sensitive material utilizing a hydrazine nucleating agent must exhibit a dot %

fluctuation of 15% or less and a  $\gamma$  value of 10 or more, when it is used in combination of the processing method of the present invention.

In the present invention, the light-sensitive material

5 may contain an amine derivative, onium salt, disulfide derivative or hydroxymethyl derivative as a nucleation accelerator. Examples of the nucleation accelerator used in the present invention include compounds described in JP-A-7-77783, page 48, lines 2 to 37, specifically, Compounds A-1) to A-73)

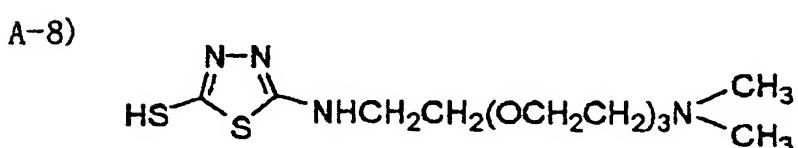
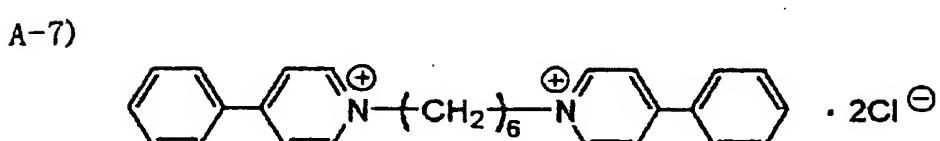
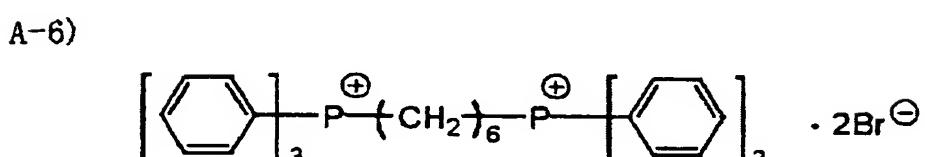
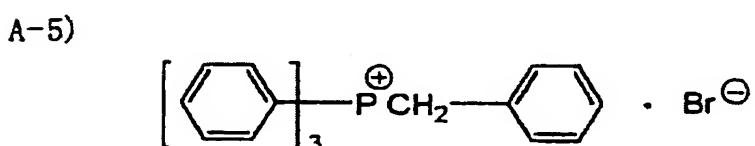
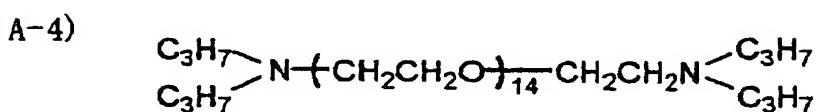
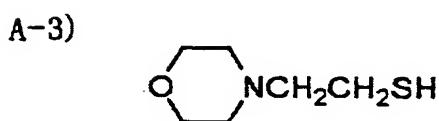
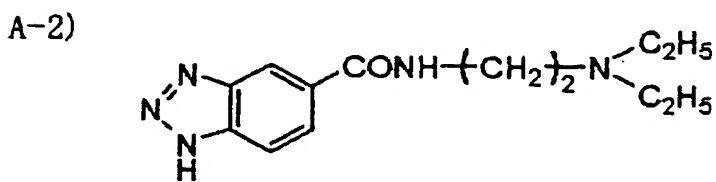
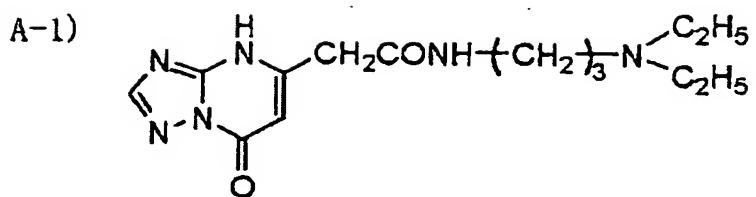
10 described on pages 49 to 58 of the same; compounds represented by (Chemical formula 21), (Chemical formula 22) and (Chemical formula 23) described in JP-A-7-84331, specifically, compounds described on pages 6 to 8 of the same; compounds represented by formulas [Na] and [Nb] described in JP-A-7-104426, specifically,

15 Compounds Na-1 to Na-22 and Compounds Nb-1 to Nb-12 described on pages 16 to 20 of the same; compounds represented by the formulas (1), (2), (3), (4), (5), (6) and (7) described in JP-A-8-272023, specifically, Compounds 1-1 to 1-19, Compounds 2-1 to 2-22, Compounds 3-1 to 3-36, Compounds 4-1 to 4-5, Compounds

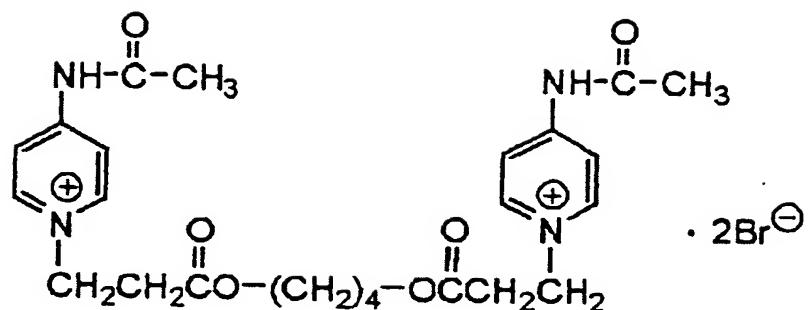
20 5-1 to 5-41, Compounds 6-1 to 6-58 and Compounds 7-1 to 7-38 mentioned in the same; and nucleation accelerators described in JP-A-9-297377, p.55, column 108, line 8 to p.69, column 136, lines 44.

Specific examples of the nucleating agent used for the

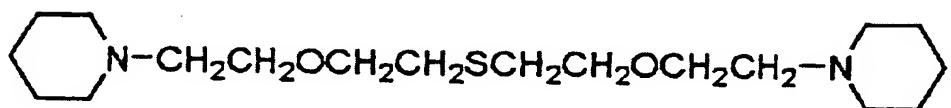
25 present invention are illustrated below. However, nucleating agents that can be used for the present invention are not limited to these.



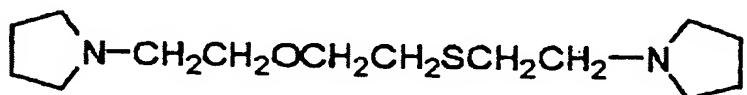
A-9)



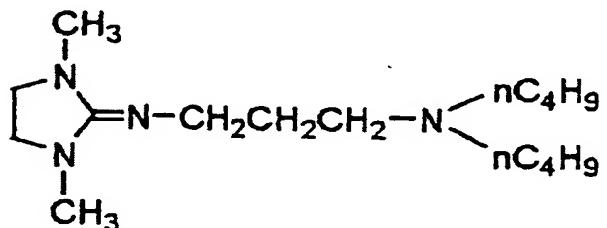
A-10)



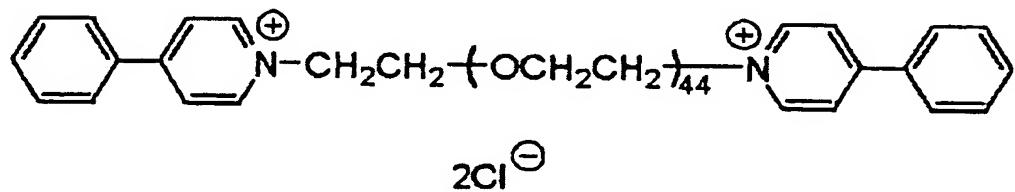
A-11)



A-12)



A-13)



The nucleation accelerators that can be used in the present invention may be dissolved in an appropriate water-miscible organic solvent such as an alcohol (e.g., methanol, ethanol, propanol or a fluorinated alcohol), ketone (e.g., 5 acetone or methyl ethyl ketone), dimethylformamide, dimethylsulfoxide or methyl cellosolve and used.

Alternatively, the nucleation accelerator may also be dissolved in an oil such as dibutyl phthalate, tricresyl phosphate, glyceryl triacetate or diethyl phthalate using an 10 auxiliary solvent such as ethyl acetate or cyclohexanone and mechanically processed into an emulsion dispersion by a conventionally well-known emulsion dispersion method before use. Alternatively, powder of the nucleation accelerator may be dispersed in water by means of ball mill, colloid mill or 15 ultrasonic waves according to a method known as solid dispersion method and used.

The nucleation accelerator may be added to any of a silver halide emulsion layer and other hydrophilic colloid layers on the silver halide emulsion layer side with respect to 20 the support. However, it is preferably added to a hydrophilic colloid layer adjacent to the silver halide emulsion layer.

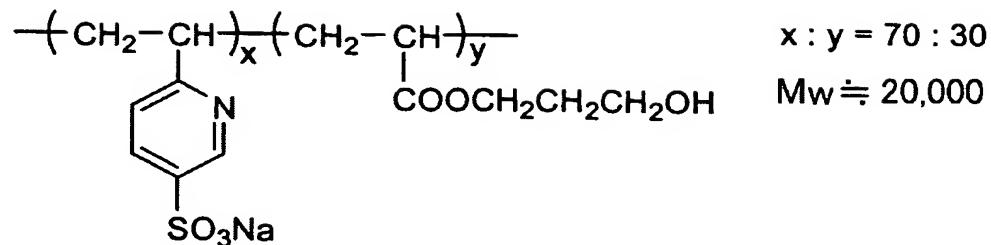
The amount of the nucleation accelerator (mol/mol Ag) is preferably 1 to 8 times, more preferably 1 to 6 times, as much as the amount of the nucleating agent (mol/mol Ag). It is also 25 possible to use two or more kinds of nucleation accelerators in combination.

The silver halide photographic light-sensitive material

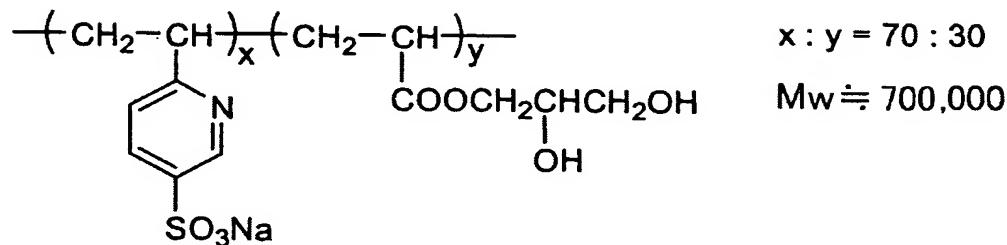
of the present invention preferably contains a conductive polymer. As the conductive polymer used for the present invention, a water-soluble conductive polymer can be used. Examples include, for example, polymers having at least one 5 kind of conductive group selected from sulfonic acid group, a sulfuric acid ester group, a tertiary ammonium salt group, a quaternary ammonium salt group, carboxyl group and a polyethylene oxide group. Among these groups, sulfonic acid group, a sulfuric acid ester group and a quaternary ammonium 10 salt group are preferred. The conductive group is preferably contained in an amount of 5 weight % or more per one polymer molecule.

Examples of specific compounds as the water-soluble conductive polymer used for the present invention are mentioned 15 below. Examples of specific compounds also include P-9 to P-37 described in JP-A-4-80744, and these are similarly preferably used.

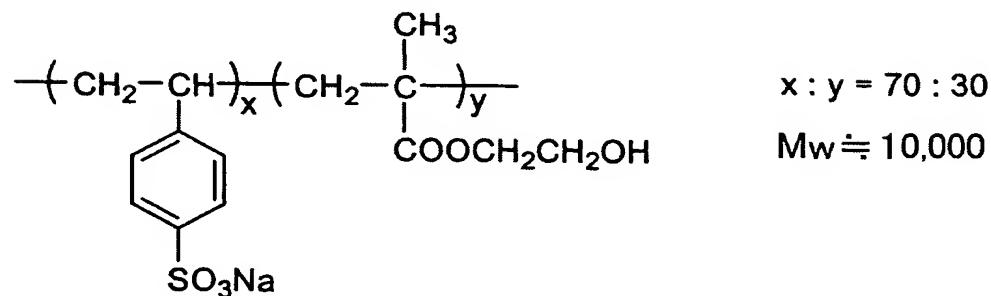
P - 1



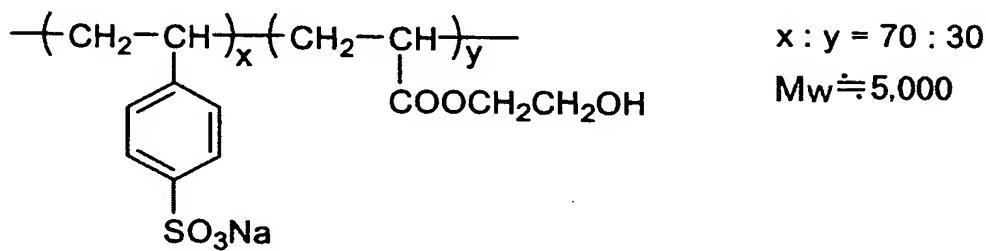
P - 2



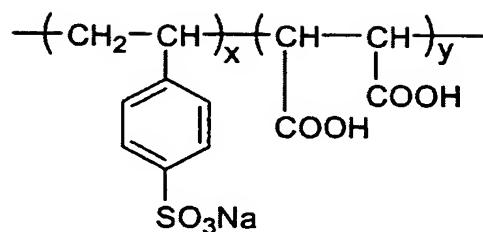
P - 3



P - 4



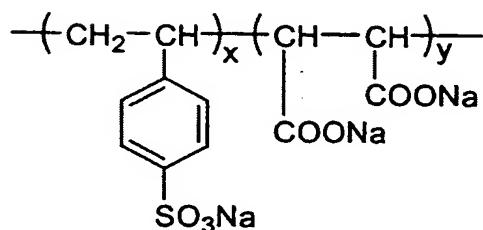
P - 5



$x : y = 75 : 25$

$M_w \doteq 5,000$

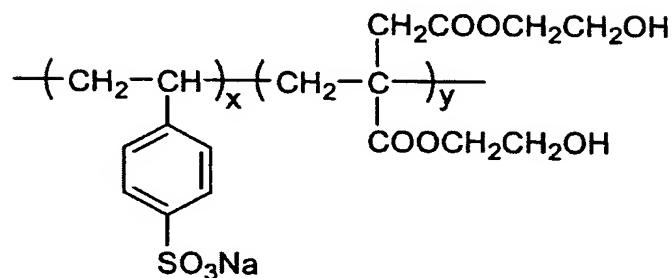
P - 6



$x : y = 65 : 35$

$M_w \doteq 120,000$

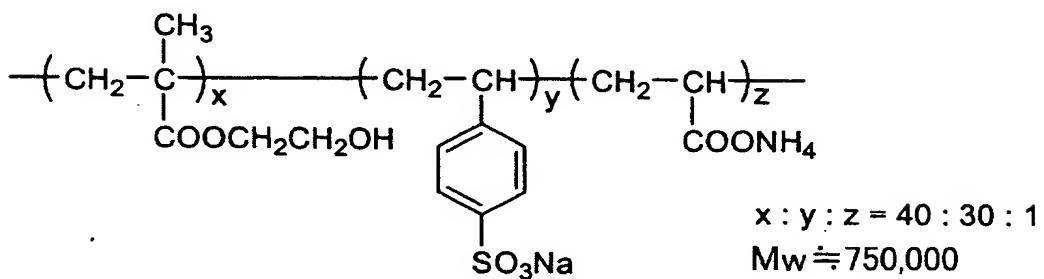
P - 7



$x : y = 98 : 2$

$M_w \doteq 200,000$

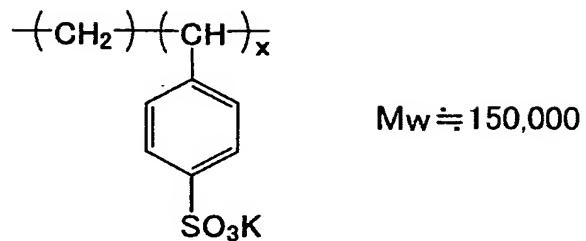
P - 8



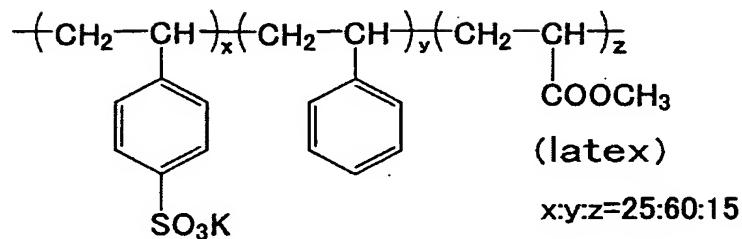
$x : y : z = 40 : 30 : 1$

$M_w \doteq 750,000$

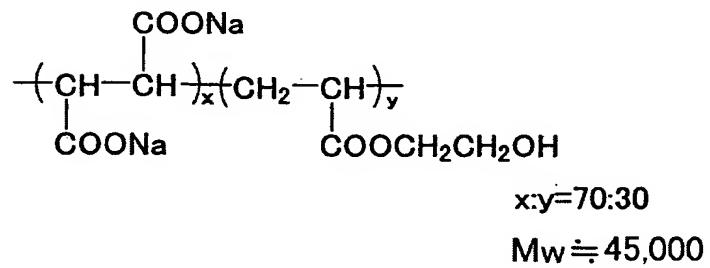
P-9



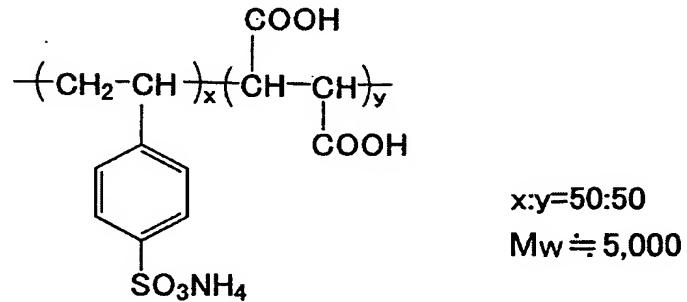
P-10



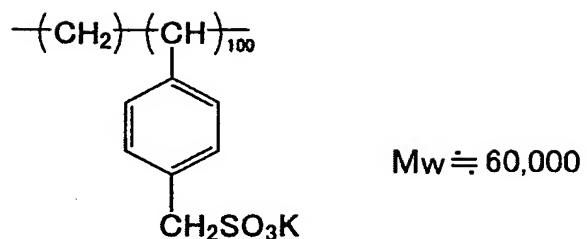
P-11



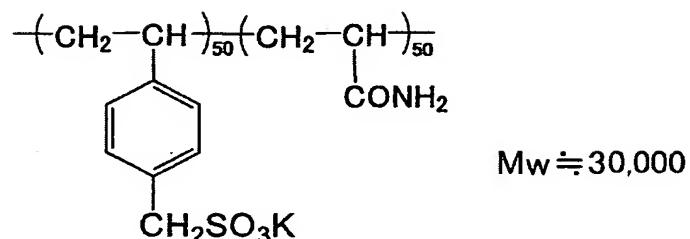
P-12



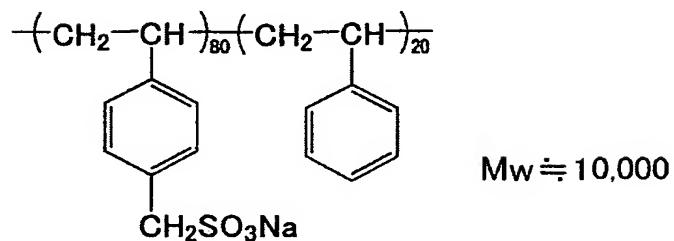
P-13



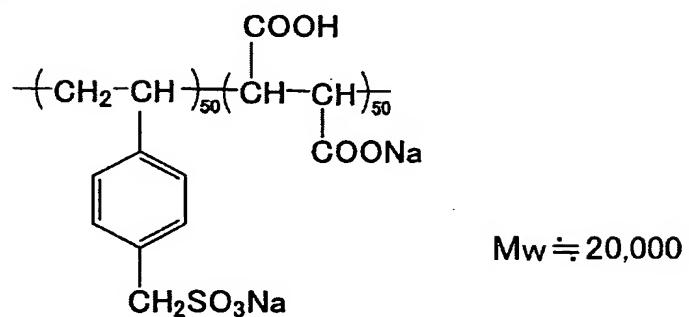
P-14



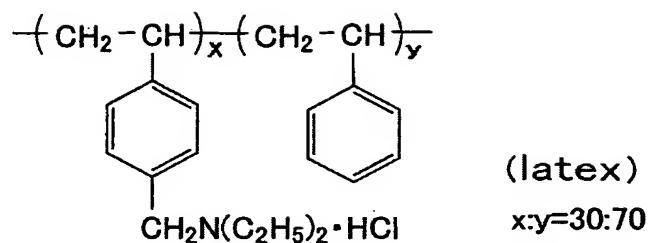
P-15



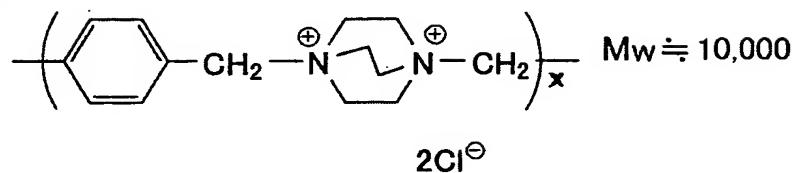
P-16



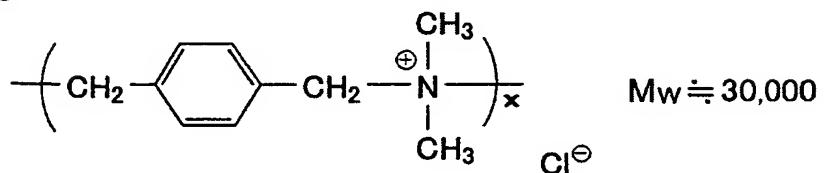
P-17



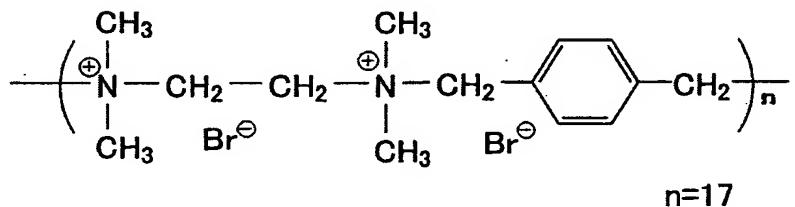
P-18



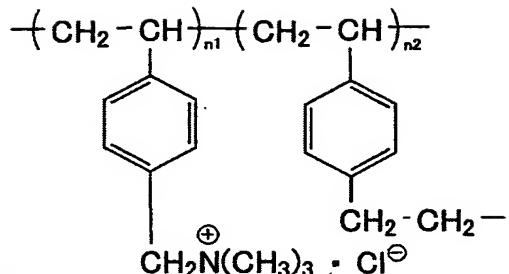
P-19



P-20

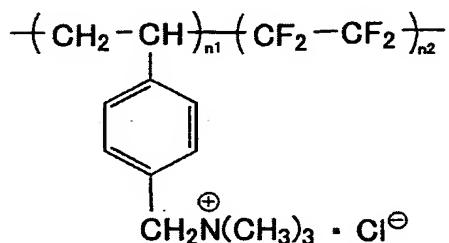


P-21



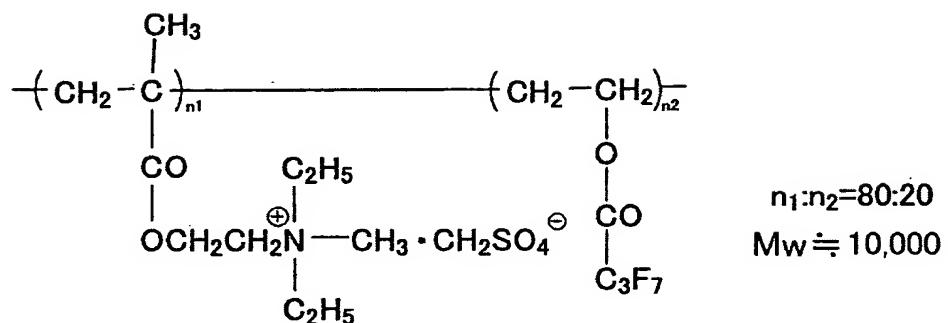
(latex)  
 $n_1:n_2=90:10$

P-22



$n_1:n_2=60:40$   
 $M_w \doteq 40,000$

P-23



$n_1:n_2=80:20$   
 $M_w \doteq 10,000$

In P-1 to P-8 mentioned above, x, y and z represent mole % of each monomer component, and M represents an average molecular weight (average molecular weight refers to number 5 average molecular weight in this specification).

In the present invention, it is preferred that at least one layer constituting the silver halide light-sensitive material has a conductive layer having a surface resistivity of  $10^{12} \Omega$  or less in an atmosphere of  $25^\circ\text{C}$  and 25% relative

humidity (antistatic layer). More preferably, the conductive layer is a conductive layer having a surface resistivity of  $10^{11}$   $\Omega$  or less.

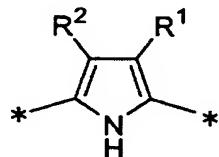
As a conductive substance used for the present invention, 5 the conductive substances described in JP-A-2-18542, page 2, lower left column, line 13 to page 3, upper right column, line 7, specifically the metal oxides described on page 2, lower right column, line 2 to line 10 of the same and Compounds P-1 to P-7 described in the same, acicular metal oxides described 10 in U.S. Patent No. 5,575,957, JP-A-10-142738, paragraphs 0034 to 0043, JP-A-11-223901, paragraphs 0013 to 0019 and so forth can be used.

Preferred water-soluble conductive polymers contained in the conductive layer of the present invention are compounds 15 preferably having a molecular weight of 100 to 10,000,000, particularly preferably 10,000 to 500,000 in which sulfonic acid group or a salt of sulfonic acid group bonds to an aromatic ring or heterocyclic group directly or via a divalent bridging group. These polymers can easily be synthesized by 20 polymerizing commercially available monomers or monomers obtained by a conventional method.

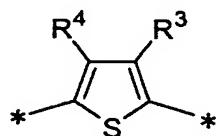
The amount of the water-soluble conductive polymer contained in the conductive layer of the silver halide photographic light-sensitive material of the present invention 25 is preferably 0.001 g to 10 g, more preferably 0.01 g to 5 g, per  $m^2$  of the light-sensitive material in terms of the solid content.

Examples of preferred conductive polymer used for the present invention further include substituted or unsubstituted pyrrole-containing polymers, substituted or unsubstituted thiophene-containing polymers and substituted or unsubstituted 5 aniline-containing polymers, and they include conjugated type polymer compounds constituted by repeating units consisting of at least one kind of unit selected from the pyrrole type unit represented by the following formula (1), thiophene type unit represented by the formula (2) and aniline type unit 10 represented by the formula (3).

Formula (1)

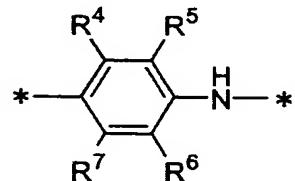


Formula (2)



15

Formula (3)



In the formulas,  $R^1$  to  $R^8$  may be the same or different, and they represent hydrogen atom or a straight, cyclic or branched alkyl group or alkoxy group having 1 to 20 carbon atoms. The symbol \* represents the bonding positions of the 5 repeating units.

Examples of the straight, cyclic or branched alkyl group or alkoxy group having 1 to 20 carbon atoms represented by  $R^1$  to  $R^8$  include, for example, methyl group, ethyl group, propyl group, butyl group, octyl group, methoxy group, ethoxy group 10 and so forth.

In particular, polypyrroles, polythiophenes and polyanilines consisting only one kind of the repeating units represented by the formulas (1), (2) and (3), respectively, are preferably used.

15 The polymer compounds containing the aforementioned repeating units can be produced by oxidatively polymerizing monomers that can constitute at least one of the repeating units represented by the formula (1), (2) or (3).

Specific examples of the monomers represented by the 20 aforementioned formula (1), (2) or (3) include pyrrole, thiophene, 3-methylthiophene, 3-octylthiophene, 3-methoxythiophene, aniline, bithiophene, terthiophene, trans-bithienylethylene, trans-bithienyl-1,4-butadiene, bipyrrole, terpyrrole, 2,5-bipyrrolylthiophene, *p,p'*-bipyrrolylbenzene, 25 2,5'-biphenylterpyrrole, 2,5'-bithienylbipyrrole and so forth.

The substituted or unsubstituted pyrrole-containing polymers, substituted or unsubstituted thiophene-containing

polymers and substituted or unsubstituted aniline-containing polymers mentioned above as the conductive polymers can reduce the specific surface resistance of the light-sensitive material to  $10^{11} \Omega$  or less with a small content, for example, several to 5 100 mg/m<sup>2</sup>, and the specific surface resistance is basically hardly influenced by humidity. Therefore, even under a low humidity of 20% or less as relative humidity, the low specific surface resistance can be maintained. However, since these conductive polymers mentioned above show a tendency that they 10 are more hardly soluble in water compared with the water-soluble conductive polymers described above, they may generate coating defects such as repelling and uneven coating when a hydrophilic colloid utilizing gelatin or the like as a main component is provided as an upper layer. The amount of the 15 polymers is preferably 1 to 1000 mg, more preferably 10 to 100 mg, per 1 m<sup>2</sup> of one side of the light-sensitive material.

The conductive layer comprising the conductive polymer of the present invention preferably contains a hydrophobic polymer, and the hydrophobic polymer is a hydrophobic polymer that is 20 not substantially dissolved in water in the form of so-called latex. This hydrophobic polymer can be obtained by polymerizing monomers selected from styrene, styrene derivatives, alkyl acrylates, alkyl methacrylates, olefin derivatives, halogenated ethylene derivatives, acrylamide derivatives, methacrylamide 25 derivatives, vinyl ester derivatives, acrylonitrile etc. in an arbitrary combination. Those containing at least 30 mole % of a styrene derivative, alkyl acrylate and alkyl methacrylate are

particularly preferred. The content is particularly preferably 50 mole % or more.

For producing the hydrophobic polymer in the form of latex, there are two kinds of methods including a method

5 utilizing emulsion polymerization and a method utilizing pulverization of a solid polymer dissolved in a solvent having a low boiling point followed by evaporation of the solvent.

However, the emulsion polymerization is preferred, because it can provides fine and uniform particle size.

10 As a surfactant used in the emulsion polymerization, an anionic or nonionic surfactant is preferably used, and it is preferably used in an amount of 10 weight % or less based on the monomers. A large amount of surfactant causes cloudiness of the conductive layer.

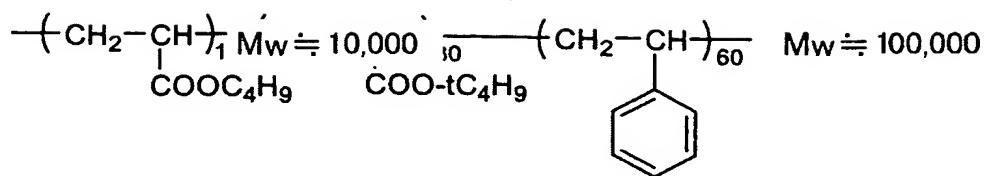
15 The molecular weight of the hydrophobic polymer is preferably 3000 or more, and difference of molecular weight provides almost no difference of transparency.

The amount of the hydrophobic polymer is preferably 0.02 g to 2.0 g, more preferably 0.1 g to 1.0 g, per 1 m<sup>2</sup> of the

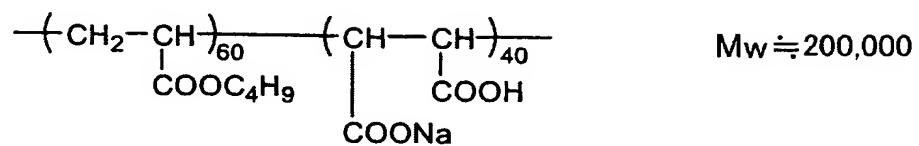
20 light-sensitive material.

Examples of the hydrophobic polymer preferably used for the conductive layer of the present invention are mentioned below.

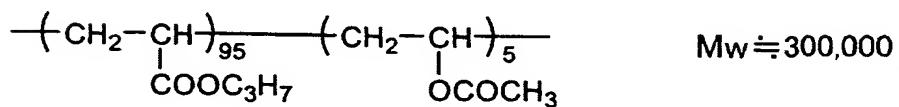
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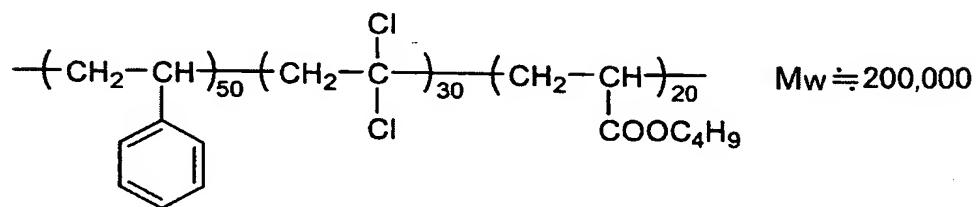
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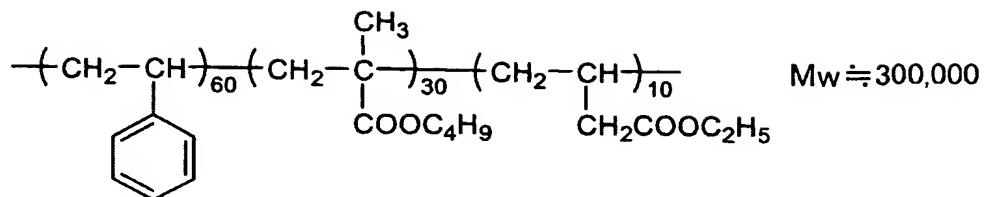
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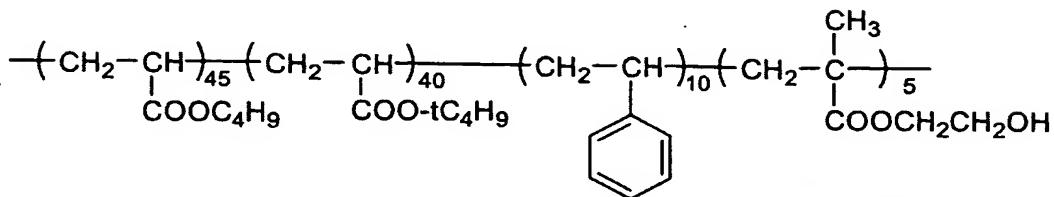
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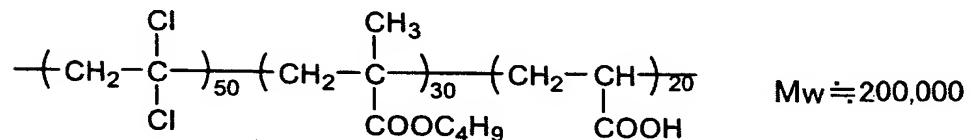
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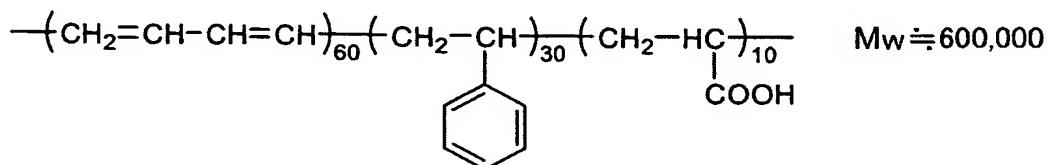
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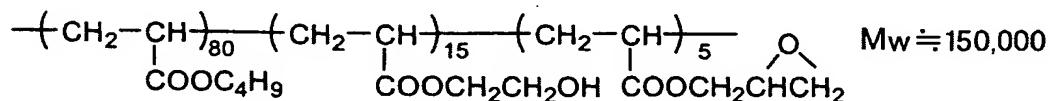
L - 7



L - 8



L - 9



Examples of preferred curing agents used for the conductive layer of the present invention include various curing agents such as those of the types mentioned below.

5 (1) Blocked isocyanate type

- (2) Multifunctional aziridine type
- (3)  $\alpha$ -Cyanoacrylate type
- (4) Epoxy type, containing triphenylphosphine
- (5) Bifunctional ethylene oxide type, cured by electron beam or

5 X-ray irradiation

- (6) N-Methylol type
- (7) Metal complex type, containing zinc and zirconium metals
- (8) Silane coupling agent type
- (9) Active carboxyl group type

10 Specific examples of these curing agents are described in  
JP-A-7-239531.

The amount of the aforementioned curing agents used for the conductive layer of the present invention is preferably  $1 \times 10^{-6}$  to  $1 \times 10^{-1}$  mole, more preferably  $1 \times 10^{-4}$  to  $1 \times 10^{-2}$  mole,  
15 per  $1 \text{ dm}^2$  of the light-sensitive material.

The surface of the conductive layer can be activated by corona discharge, glow discharge, ultraviolet irradiation, flame treatment or the like. A particularly preferred activation treatment is a corona discharge treatment, and the  
20 treatment is preferably performed at an energy intensity of 1 mW to  $1 \text{ kW}/\text{m}^2 \cdot \text{min}$ . The energy intensity is particularly preferably in the range of 0.1 to 1  $\text{W}/\text{m}^2 \cdot \text{min}$ .

A coating solution for conductive layer containing a conductive polymer is preferably directly coated on a surface  
25 of the support on the emulsion layer side, or coated after the surface of the support is undercoated. For the purpose of reinforcing the conductive layer film, the crosslinking degree

may be arbitrarily determined. However, since the mixing ratio of the conductive polymer and the hydrophobic polymer, coating and drying conditions, type and amount of the curing agent and so forth influence on the performance, it is preferred that the 5 conditions should be suitably selected in order to obtain the desired performance. A preferred crosslinking degree of the conductive layer after coating and drying can be attained by suitably selecting these conditions.

The crosslinking degree obtained by the curing agent in 10 the conductive layer can be determined from swelling degree.

The swelling degree can be determined as follows. That is, a sample of the light-sensitive material of the present invention is immersed in pure water at 25°C for 60 minutes, while an adapter enabling thickness measurement of the swelled film in 15 water is attached to the sample. Then, the sample is observed with an electron microscope, and the obtained film thickness is compared with the dry film thickness to determine the swelling degree. The swelling degree can be obtained in accordance with the following equation.

20 
$$[(\text{Thickness of film swelled by immersion}) - (\text{Dry film thickness})]/(\text{Dry film thickness}) \times 100$$

The swelling degree is preferably 0.2 to 300%, more preferably 2 to 200%.

The thickness of the conductive layer closely relates to 25 the conductivity, and since the conductivity is improved by increase of unit volume, a larger thickness is preferred. However, it is preferably 0.1 to 10  $\mu\text{m}$ , particularly preferably

0.1 to 3  $\mu\text{m}$ , in view of cost or maintenance of film adhesion performance.

Moreover, an adhesive layer comprising gelatin or a gelatin derivative can be prepared on the conductive layer. The adhesive layer is laminated simultaneously with coating of the conductive layer, or can be coated after the conductive layer is dried. This adhesive layer is preferably subjected to a heat treatment at a temperature of 70 to 200°C. Various kinds of hardening agents can be used for this adhesive layer, and it can be arbitrarily selected from acrylamide type, aldehyde type, aziridine type, peptide type, epoxy type, vinyl sulfone type hardening agents and so forth taking the crosslinking of the conductive layer as a lower layer and the crosslinking with the upper layer into consideration.

The silver halide photographic light-sensitive material of the present invention preferably contains such composite latex as described in JP-A-10-325989, which comprises inorganic particles and organic polymer, in the emulsion layer.

In the present invention, the composite latex refers to a dispersion of composite polymer microparticles comprising inorganic microparticles and hydrophobic polymer, in particular, a dispersion of composite polymer microparticles formed by polymerizing hydrophobic monomers in the presence of inorganic microparticles in a composition containing them.

Examples of the inorganic microparticles used for the composite latex comprising colloidal inorganic microparticles and hydrophobic polymer used for a hydrophilic colloid layer in

the present invention include those of metal oxides, nitrides, sulfides and so forth, and those of metal oxides are preferred.

As the metal oxide microparticles, those of single metal oxides or composite metal oxides of Na, K, Ca, Ba, Al, Zn, Fe, 5 Cu, Ti, Sn, In, W, Y, Sb, Mn, Ga, V, Nb, Tu, Ag, Bi, B, Si, Mo, Ce, Cd, Mg, Be, Pb and so forth are preferred, and those of single metal oxides or composite metal oxides of Y, Sn, Ti, AL, V, Sb, In, Mn, Ce, B and Si are particularly preferred in view of misciblity with emulsions.

10 Although these metal oxides of crystalline type or amorphous type may be used, amorphous metal oxide microparticles can be particularly preferably used. The average particle size of the metal oxides is preferably 0.5 to 3000 nm, particularly preferably 3 to 500 nm. These metal oxides are 15 preferably used after dispersed in water or and/or a solvent soluble in water.

The amount of the metal oxide used in the present invention is preferably 1 to 2000 weight %, particularly preferably 30 to 1000 weight %, with respect to the hydrophobic 20 polymer. Examples of preferred metal oxides are shown below.

SO-1:  $\text{SiO}_2$

SO-2:  $\text{TiO}_2$

SO-3:  $\text{ZnO}$

SO-4:  $\text{SnO}_2$

25 SO-5:  $\text{MgO}$

SO-6:  $\text{MnO}_2$

SO-7:  $\text{Fe}_2\text{O}_3$

SO-8: ZnSiO<sub>4</sub>  
SO-9: Al<sub>2</sub>O<sub>3</sub>  
SO-10: BeSiO<sub>4</sub>  
SO-11: Al<sub>2</sub>SiO<sub>5</sub>  
5 SO-12: ZrSiO<sub>4</sub>  
SO-13: CaWO<sub>4</sub>  
SO-14: CaSiO<sub>3</sub>  
SO-15: InO<sub>2</sub>  
SO-16: SnSbO<sub>2</sub>  
10 SO-17: Sb<sub>2</sub>O<sub>5</sub>  
SO-18: Nb<sub>2</sub>O<sub>5</sub>  
SO-19: Y<sub>2</sub>O<sub>3</sub>  
SO-20: CeO<sub>2</sub>  
SO-21: Sb<sub>2</sub>O<sub>3</sub>  
15 SO-22: Na<sub>2</sub>O

Examples of the hydrophobic monomer forming the hydrophobic polymer in the composite latex of the present invention include, for example, one kind or combinations of two or more kinds of hydrophobic monomers selected from acrylic acid esters, methacrylic acid esters, vinyl esters, olefins, styrenes, crotonic acid esters, itaconic acid diesters, maleic acid diesters, fumaric acid diesters, allyl compounds, vinyl ethers, vinyl ketones, vinyl heterocyclic compounds, glycidyl esters, unsaturated nitriles, and various unsaturated acids.

25 The hydrophobic monomer forming the hydrophobic polymer is preferably selected from acrylic acid esters and/or methacrylic acid esters and styrenes, and the ester groups of these

particularly preferably have 6 or more carbon atoms.

Further, it is preferable to use a hydrophobic monomer consisting of any of these hydrophobic monomers and having a glycidyl group in an amount of at least 1.0 to 20 weight %,

5 preferably 2.0 to 10 weight %.

The hydrophobic polymer forming the composite latex of the present invention is preferably copolymerized with a hydrophilic monomer in addition to the hydrophobic monomer. As such a hydrophilic monomer, for example, carboxyl group-

10 containing monomers such as acrylic acid and methacrylic acid, hydroxyl group-containing monomers such as hydroxyethyl acrylate, alkylene oxide-containing monomers, acrylamides, methacrylamides, sulfonic acid group-containing monomers, amino group-containing monomers and so forth can be preferably used.

15 The hydrophobic polymer particularly preferably contains a hydroxyl group-containing monomer, carboxyl group-containing monomer, amide group-containing monomer or sulfone group-containing monomer.

If these hydrophilic monomers are added in a large amount, 20 they are dissolved in water. Therefore, they are preferably used in an amount of about 0.1 to 30 weight %, particularly preferably 1.0 to 20 weight %.

The composite latex of the present invention can be made into composite latex having crosslinking groups by selecting 25 the kinds of the aforementioned hydrophobic monomer and/or hydrophilic monomer so as to use a hydrophobic monomer having a crosslinking group such as carboxyl group, glycidyl group,

amino group, amide group and N-methylol group.

The composite latex of the present invention may contain a monomer having at least two of polymerizable ethylenically unsaturated bonds. Examples of such a monomer include, for 5 example, those having two of vinyl groups such as divinylbenzene, ethylene glycol diacrylate, ethylene glycol dimethacrylate, diethylene glycol diacrylate, diethylene glycol dimethacrylate and N,N-methylenebisacrylamide, those having three of vinyl groups such as trivinylcyclohexane, 10 trimethylolpropane triacrylate, trimethylolpropane trimethacrylate and pentaerythritol trimethacrylate, and those having four of vinyl groups such as pentaerythritol tetraacrylate and pentaerythritol tetramethacrylate. However, the monomer having at least two of ethylenically unsaturated 15 bonds is not limited to these.

The average particle size of the composite latex of the present invention is particularly preferably 0.01 to 0.8  $\mu\text{m}$  in terms of the weight average particle size, and any of those having a weight average particle size of 0.005 to 3.0  $\mu\text{m}$  can 20 preferably be used.

Examples of the polymerization method used for preparing the composite latex of the present invention include, for example, emulsion polymerization, solution polymerization, mass polymerization, suspension polymerization, radiation 25 polymerization and so forth.

(Solution polymerization)

The latex can be obtained by performing polymerization at

a temperature of about 10 to 200°C, preferably 30 to 120°C, for about 0.5 to 48 hours, preferably 2 to 20 hours, in a composition containing the monomers at an appropriate concentration (usually 40 weight % or less, preferably about 10 5 to 25 weight %) in a solvent in the presence of a polymerization initiator. Any polymerization initiator may be employed so long as a polymerization initiator that is soluble in the polymerization solvent is selected, and examples include organic solvent type initiators such as benzoyl peroxide, 10 azobisisobutyronitrile (AIBN) and di-tert-butyl peroxide, water-soluble initiators such as ammonium persulfate (APS), potassium peroxide and 2,2'-azobis-(2-amidinopropane) hydrochloride, redox type polymerization initiators such as those consisting of the aforementioned initiators combined with 15 a reducing agent such as a  $\text{Fe}^{2+}$  salt and sodium hydrogensulfite and so forth.

The solvent may be one that can dissolve the composition of monomers, and examples include water, methanol, ethanol, dimethyl sulfoxide, dimethylformamide, dioxane, mixed solvents 20 of two or more kinds of these and so forth. After completion of the polymerization, the reaction mixture can be poured into a solvent that does not dissolve the produced polymer compound to precipitate the product, and then the product can be dried to separate and remove the unreacted compounds.

25 (Emulsion polymerization)

The latex can be obtained by using water as a dispersion medium in an amount of 1 to 50 weight % with respect to water,

a polymerization initiator in an amount of 0.05 to 5 weight % with respect to the monomers and a dispersing agent in an amount of 0.1 to 20 weight % with respect to the monomers to perform polymerization of the monomers at a temperature of 5 about 30 to 100°C, preferably 60 to 90°C, for about 3 to 8 hours with stirring.

Any polymerization initiator may be employed so long as a polymerization initiator that is soluble in the polymerization solvent is selected, and examples include organic solvent type 10 initiators such as benzoyl peroxide, azobisisobutyronitrile (AIBN) and di-tert-butyl peroxide, water-soluble initiators such as ammonium persulfate (APS), potassium peroxide and 2,2'-azobis-(2-amidinopropane) hydrochloride, redox type polymerization initiators such as those consisting of the 15 aforementioned initiators combined with a reducing agent such as a  $\text{Fe}^{2+}$  salt and sodium hydrogensulfite and so forth.

The solvent may be one that can dissolve the mixture of monomers, and examples include water, methanol, ethanol, dimethyl sulfoxide, dimethylformamide, dioxane, mixed solvents 20 of two or more kinds of these and so forth. After completion of the polymerization, the reaction mixture can be poured into a medium that does not dissolve the produced copolymer to precipitate the product, and then the product can be dried to separate and remove the unreacted compounds.

25 In the emulsion polymerization, the latex can be obtained by performing polymerization using water as a dispersion medium, monomers in an amount of 10 to 50 weight % with respect to

water, a polymerization initiator in an amount of 0.05 to 5 weight % with respect to the monomers and a dispersing agent in an amount of 0.1 to 20 weight % with respect to the monomers at a temperature of about 30 to 100°C, preferably 60 to 90°C, for 5 about 3 to 8 hours with stirring. The concentration of monomers, amount of initiator, reaction temperature, reaction time and so forth can be readily changed within wide ranges.

Examples of the polymerization initiator include water-soluble peroxides (e.g., potassium persulfate, ammonium 10 persulfate etc.), water-soluble azo compounds (e.g., 2,2'-azobis-(2-amidinopropane) hydrochloride etc.), redox type polymerization initiators such as those consisting of the aforementioned initiators combined with a reducing agent such as a  $\text{Fe}^{2+}$  salt and sodium hydrogensulfite and so forth.

15 A water-soluble polymer is used as the dispersing agent for the composite polymer compound of the present invention, and any of an anionic surfactant, nonionic surfactant, cationic surfactant and amphoteric surfactant can be used.

Examples of the water-soluble polymer used as the 20 dispersing agent for the composite polymer compound of the present invention include, for example, synthetic polymers and natural water-soluble polymers by the present invention, and any of these can be preferably used in the present invention.

Among these, examples of the synthetic water-soluble polymer 25 include those having, for example, a nonionic group, an anionic group, a cationic group, a nonionic group and an anionic group, a nonionic group and a cationic group, or an anionic group and

a cationic group in the molecular structure. Examples of the nonionic group include, for example, an ether group, an alkylene oxide group, hydroxy group, an amide group, an amino group and so forth. Examples of the anionic group include, for example, carboxylic acid group or a salt thereof, a phosphoric acid group or a salt thereof, a sulfonic acid group or a salt thereof and so forth. Examples of the cationic group include, for example, a quaternary ammonium salt group, a tertiary amino group and so forth.

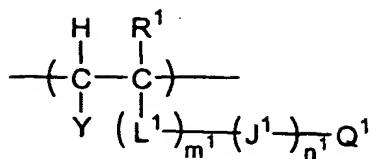
10 Examples of the natural water-soluble polymers also include those having, for example, a nonionic group, an anionic group, a cationic group, a nonionic group and an anionic group, a nonionic group and a cationic group, or an anionic group and a cationic group in the molecular structure.

15 As for the water-soluble polymers, those having an anionic group and those having a nonionic group and a anionic group can be preferably used for both of the synthetic water-soluble polymers and natural water-soluble polymers.

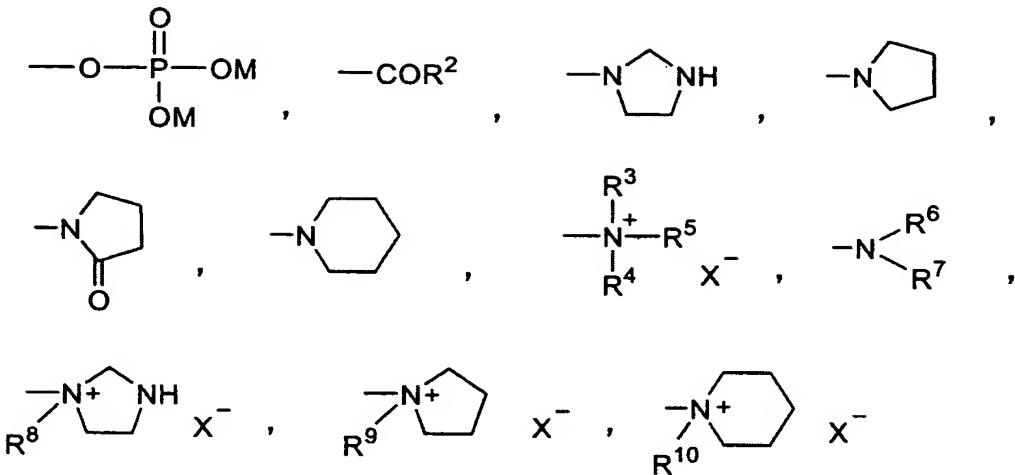
In the present invention, it is sufficient that the  
20 water-soluble polymer is dissolved in an amount of 0.05 g or more, preferably 0.1 g or more, in 100 g of water at 20°C. Examples of the synthetic water-soluble polymer include those containing 10 to 100 mol % of repeating units represented by the following formula (9) and/or (10) per 1 polymer molecule.

25

Formula (9)



In the formula,  $\text{R}^1$  represents hydrogen atom, an alkyl group, a halogen atom or a  $-\text{CH}_2\text{COOM}$  group, preferably an alkyl group having 1 to 4 carbon atoms.  $\text{L}^1$  represents a divalent bridging group, and examples include, for example,  $-\text{CONH}-$ ,  $-\text{NHCO}-$ ,  $-\text{COO}-$ ,  $-\text{OCO}-$ ,  $-\text{CO}-$ ,  $-\text{O}-$  and so forth.  $\text{J}^1$  represents an alkylene group, an arylene group or a polyoxyalkylene group.  $\text{Q}^1$  represents  $-\text{OM}$ ,  $-\text{NH}_2$ ,  $-\text{SO}_3\text{M}$ ,  $-\text{COOM}$  or any of the following groups.

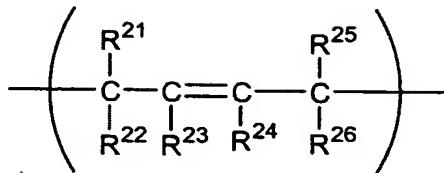


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Among these,  $-\text{COOM}$  and  $-\text{SO}_3\text{M}$  are preferred, and  $-\text{SO}_3\text{M}$  is particularly preferably used.  $\text{M}$  represents hydrogen atom or a cation (for example, an alkali metal ion, an ammonium ion),  $\text{R}^2$ ,  $\text{R}^3$ ,  $\text{R}^4$ ,  $\text{R}^5$ ,  $\text{R}^6$ ,  $\text{R}^7$ ,  $\text{R}^8$ ,  $\text{R}^9$  and  $\text{R}^{10}$  each independently represent an alkyl group having 1 to 20 carbon atoms, and  $\text{X}^-$  represents an anion.  $\text{m}^1$  and  $\text{n}^1$  each independently represent 0 or 1.  $\text{Y}$  represents hydrogen atom or  $-(\text{L}^2)^{\text{m}^2}-(\text{J}^2)^{\text{n}^2}-\text{Q}^2$ , wherein  $\text{L}^2$ ,  $\text{J}^2$ ,  $\text{Q}^2$ ,  $\text{m}^2$  and  $\text{n}^2$  have the same meanings as  $\text{L}^1$ ,  $\text{J}^1$ ,  $\text{Q}^1$ ,  $\text{m}^1$  and  $\text{n}^1$ ,

respectively.

Formula (10)



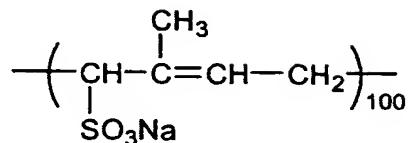
5 In the formula,  $R^{21}$ ,  $R^{22}$ ,  $R^{23}$ ,  $R^{24}$ ,  $R^{25}$  and  $R^{26}$  each independently represent hydrogen atom, an alkyl group having 1 to 8 carbon atoms, an aryl group having 6 to 20 carbon atoms or  $-SO_3X$ , wherein X represents hydrogen atom, an alkali metal atom, an alkaline earth metal atom, an ammonium group or an amino group, and at least one of  $R^{21}$  to  $R^{26}$  is  $-SO_3X$ .

10 The synthetic water-soluble polymer having a repeating unit represented by the formula (9) or (10) may be a homopolymer of the unit represented by the formula (9) or (10), or may contain another or other components.

15 Example of the other component or components include, for example, one kind or combinations of two or more kinds of components selected from acrylic acid esters, methacrylic acid esters, vinyl esters, olefins, styrenes, crotonic acid esters, itaconic acid diesters, maleic acid diesters, fumaric acid diesters, allyl compounds, vinyl ethers, vinyl ketones, glycidyl esters and unsaturated nitriles. Preferred are acrylic acid esters, methacrylic acid esters and styrenes. Specific examples of the synthetic water-soluble polymer containing a repeating unit represented by the formula (9) or (10) are

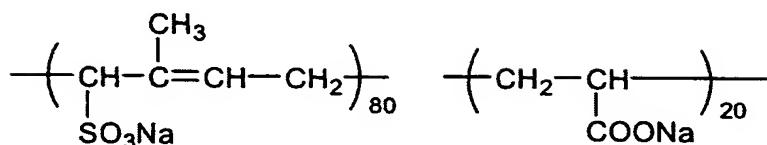
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SP - 1



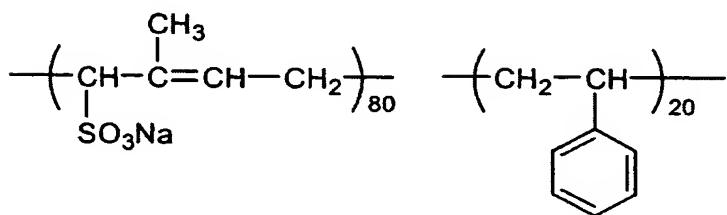
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SP - 2



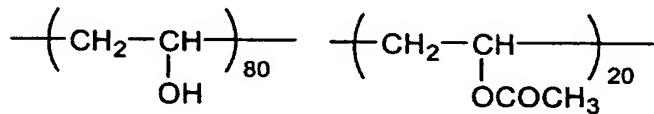
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SP - 3



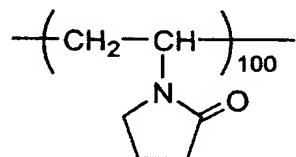
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SP - 4



Mw = 40000

SP - 5

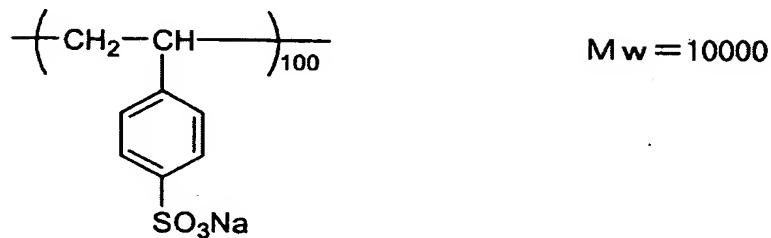


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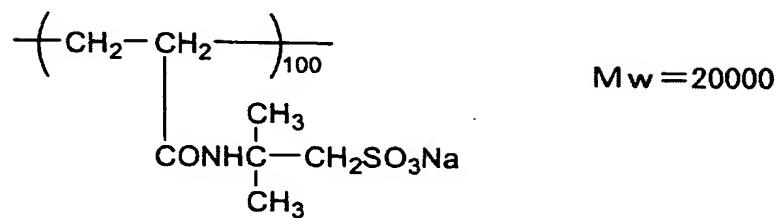
S P - 6



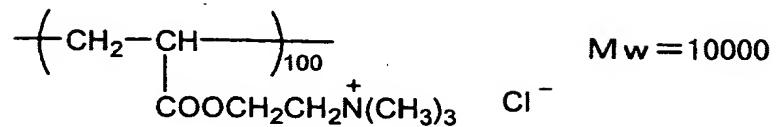
S P - 7



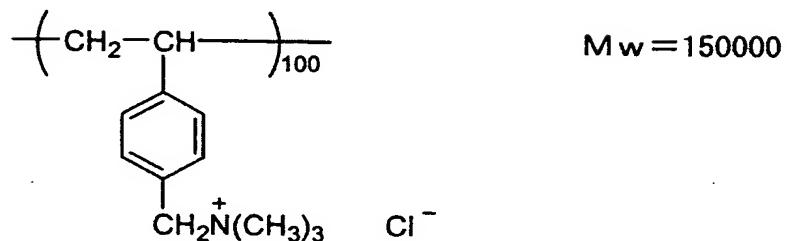
S P - 8



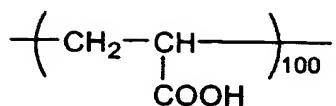
S P - 9



S P - 10

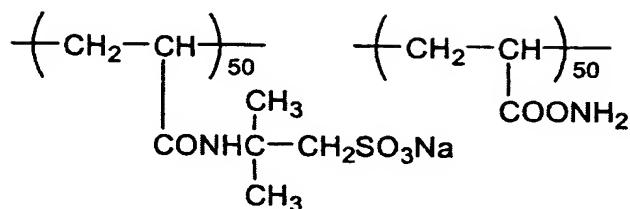


S P - 11



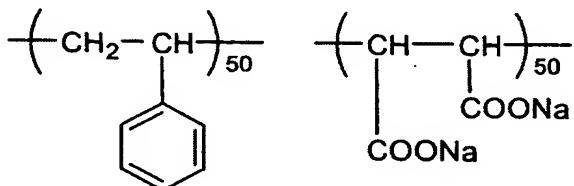
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S P - 12



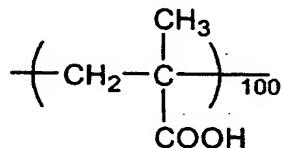
Mw = 40000

S P - 13



Mw = 5000

S P - 14



Mw = 20000

Examples of the natural water-soluble polymers which may be used as the dispersing agent for the composite polymer 5 compound include those detailed in "Methods For Dispersing Water-Soluble Polymers, Collection of Comprehensive Technical Data of Resins", Keiei Kaihatsu Center. Preferred are lignin, starch, pullulan, cellulose, dextran, dextrin, glycogen,

alginic acid, gelatin, collagen, cyamoposis gum, gum arabic, laminaran, lichenin, nigran, derivatives thereof and so forth.

As the derivatives of the natural water-soluble polymers, sulfonated, carboxylated, phosphorylated, sulfoalkylenated,

5 carboxyalkylenated and alkylphosphorylated natural water-soluble polymers and salts thereof are preferably used.

Particularly preferred are glucose, gelatin, dextran, cellulose, pullulan, glucomannan, dextrin, gellan gum, locust bean gum, xanthan gum and derivatives thereof.

10 When the composite polymer is polymerized, it is preferable to use a metal alkoxide compound. Metal alkoxide compounds include those called coupling agents, and those of various types are marketed and include silane coupling agents, titanium coupling agents, aluminum coupling agents, zirconium 15 coupling agents etc. Preferred are silane coupling agents and titanium coupling agents.

Preferred examples of the metal alkoxide compound are mentioned below. However, the metal alkoxide compounds that can be used for the present invention are not limited to these.

S T - 1       $\text{Si}(\text{OMe})_4$

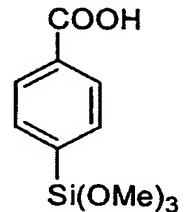
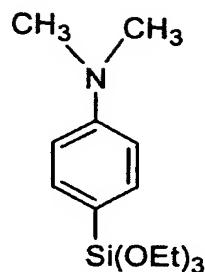
S T - 2       $\text{Ti}(\text{OPr})_4$

S T - 3       $\text{CH}_2-\text{CH}(\text{CH}_2\text{OCH}_2\text{CH}_2\text{CH}_2\text{Si}(\text{OMe})_3)-\text{O}-\text{CH}_2-\text{CH}_2$

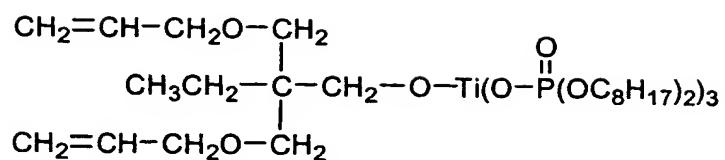
S T - 4       $\text{HS}-\text{CH}_2\text{CH}_2\text{CH}_2\text{Si}(\text{OMe})_3$

S T - 5

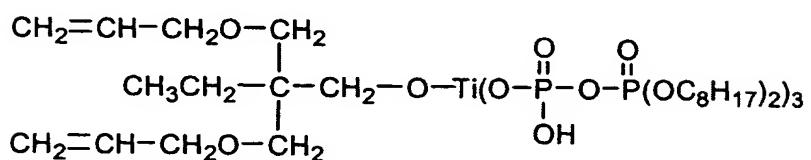
S T - 6



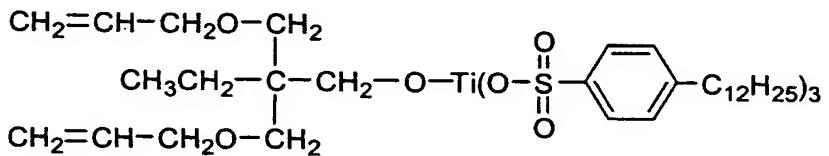
S T - 7



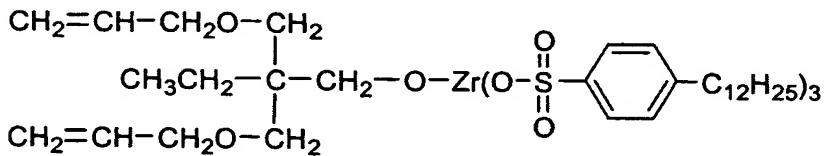
S T - 8



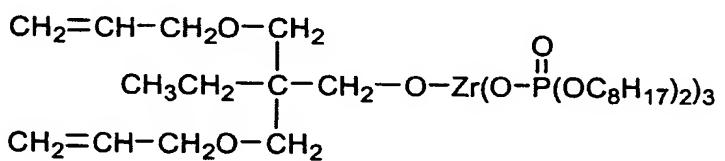
S T - 9



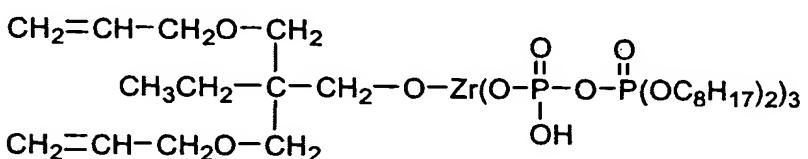
S T - 10

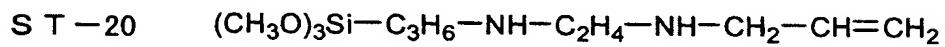
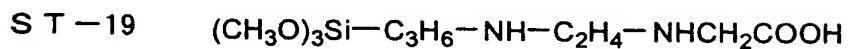
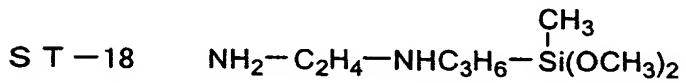
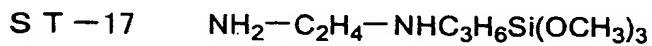
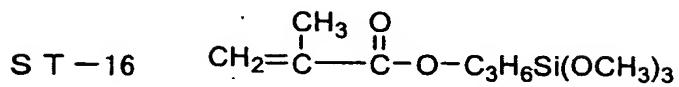
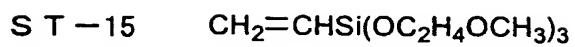
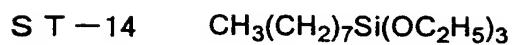


S T - 11

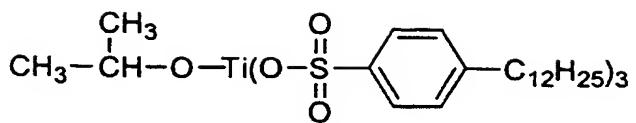


S T - 12

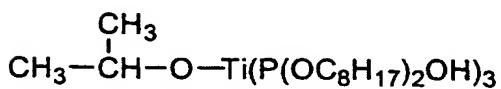




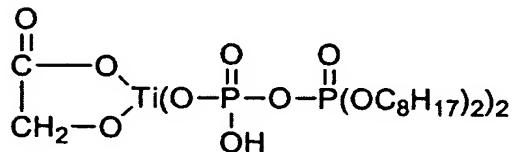
S T - 21



S T - 22



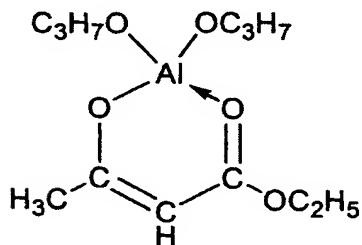
S T - 23



S T - 24



S T - 25



The composite polymer can be contained in a photographic element-constituting layer as it is or after dispersed in water. As for the dispersion method, ultrasonic waves, ball mill, attriter, pearl mill, triple-roll mill, high-speed grinder and so forth can be preferably used.

The composite polymer is preferably added in an amount of 5 to 90 weight %, particularly preferably 10 to 70 weight %, with respect to the binder of the photographic element-constituting layer. The addition site is a silver halide emulsion layer, which may be a photosensitive layer or a non-photosensitive layer.

Specific examples of the composite polymer are shown below. However, the composite polymers that can be used for the present invention are not limited to these.

No.	Hydrophobic polymer	Inorganic particles (weight % relative to hydrophobic polymer)	Metal alkoxide compound (weight % relative to hydrophobic polymer)	Dispersing agent	
				(weight % relative to hydrophobic polymer)	(weight % relative to hydrophobic polymer)
PL-1	$\begin{array}{c} \text{CH}_3 \\   \\ -\text{CH}_2-\text{C}-\text{CH}_{100} \\   \\ \text{COOCH}_3 \end{array}$	S0-17 (100)	—	—	SP-1 (10)
PL-2	$\begin{array}{c} \text{CH}_3 \\   \\ -\text{CH}_2-\text{C}-\text{CH}_{80} \\   \\ \text{COOCH}_3 \end{array}$ — $\begin{array}{c} \text{CH}_3 \\   \\ -\text{CH}_2-\text{C}-\text{CH}_{20} \\   \\ \text{COOCH}_2\text{CH}_2\text{OH} \end{array}$	S0-1 (100)	—	—	SP-5 (6)
PL-3	$\begin{array}{c} \text{CH}_3 \\   \\ -\text{CH}_2-\text{C}-\text{CH}_{80} \\   \\ \text{COOCH}_3 \end{array}$ — $\begin{array}{c} \text{CH}_3 \\   \\ -\text{CH}_2-\text{C}-\text{CH}_{20} \\   \\ \text{COOCH}_2\text{CH}_2\text{OH} \end{array}$	S0-4 (123)	—	—	hydroxypropylcellulose (22.5)
PL-4	$\begin{array}{c} \text{CH}_3 \\   \\ -\text{CH}_2-\text{CH}-\text{CH}_{90} \\   \\ \text{COOC}_2\text{H}_5 \end{array}$ — $\begin{array}{c} \text{CH}_3 \\   \\ -\text{CH}_2-\text{C}-\text{CH}_{10} \\   \\ \text{COOCH}_2\text{CH}_2\text{OH} \end{array}$	S0-1 (200)	—	—	SP-4 (5)
PL-5	$\begin{array}{c} \text{CH}_3 \\   \\ -\text{CH}_2-\text{CH}-\text{CH}_{98} \\   \\ \text{COOC}_2\text{H}_5 \end{array}$ — $\begin{array}{c} \text{CH}_2-\text{CH} \\   \\ 2 \\   \\ \text{COOH} \end{array}$	S0-1 (200)	—	—	SP-1 (1)
PL-6	$\begin{array}{c} \text{CH}_3 \\   \\ -\text{CH}_2-\text{C}-\text{CH}_{80} \\   \\ \text{COO}-\text{C}_6\text{H}_4-\text{H} \end{array}$ — $\begin{array}{c} \text{CH}_2-\text{C}-\text{CH}_{20} \\   \\ \text{COO}(\text{C}_8\text{H}_{16}) \end{array}$	S0-1 (200)	ST-3 (5)	SP-4 (10)	

No.	Hydrophobic polymer	Inorganic particles (weight % relative to hydrophobic polymer)	Metal alkoxide compound (weight % relative to hydrophobic polymer)	Dispersing agent (weight % relative to hydrophobic polymer)		
				ST-16 (5)	SP-3 (10)	SP-3 (10)
PL-7	$\begin{array}{c} \text{CH}_3 \\   \\ \text{CH}_2-\text{CH}-\text{CH}_{93} \\   \\ \text{COOC}_2\text{H}_5 \end{array}$ $\begin{array}{c} \text{CH}_3 \\   \\ \text{CH}_2-\text{CH}-\text{CH}_7 \\   \\ \text{COOC}_2\text{H}_5 \end{array}$	S0-1 (300)				
	$\begin{array}{c} \text{CH}_3 \\   \\ \text{COOC}_2\text{H}_5 \end{array}$ $\begin{array}{c} \text{CH}_3 \\   \\ \text{CH}_2-\text{CH}_2\text{CH}_2\text{OOC} \\   \\ \text{CH}_3 \end{array}$					
PL-8	$\begin{array}{c} \text{CH}_3 \\   \\ \text{CH}_2-\text{CH}-\text{CH}_{80} \\   \\ \text{COOC}_2\text{H}_5 \end{array}$ $\begin{array}{c} \text{CH}_3 \\   \\ \text{CH}_2-\text{CH}_2\text{CH}_2\text{CH}_3 \\   \\ \text{COOC}_2\text{H}_5 \end{array}$		S0-19 (100)			
	$\begin{array}{c} \text{CH}_3 \\   \\ \text{COOC}_2\text{H}_5 \end{array}$ $\begin{array}{c} \text{CH}_3 \\   \\ \text{CH}_2-\text{CH}-\text{CH}_{20} \\   \\ \text{COOC}_2\text{H}_5 \end{array}$					
PL-9	$\begin{array}{c} \text{CH}_3 \\   \\ \text{CH}_2-\text{CH}-\text{CH}_{40} \\   \\ \text{COO}(\text{i})\text{C}_9\text{H}_{10} \end{array}$		S0-4 (200)			
	$\begin{array}{c} \text{CH}_3 \\   \\ \text{COO}(\text{i})\text{C}_9\text{H}_{10} \end{array}$ $\begin{array}{c} \text{CH}_3 \\   \\ \text{CH}_2-\text{CH}-\text{CH}_{60} \\   \\ \text{COOCH}_3 \end{array}$					
PL-10	$\begin{array}{c} \text{CH}_3 \\   \\ \text{CH}_2-\text{CH}-\text{CH}_{50} \\   \\ \text{COO}-\text{C}_6\text{H}_4-\text{CH}_2 \end{array}$		S0-1 (500)			
	$\begin{array}{c} \text{CH}_3 \\   \\ \text{COO}-\text{C}_6\text{H}_4-\text{CH}_2 \end{array}$ $\begin{array}{c} \text{CH}_3 \\   \\ \text{CH}_2-\text{CH}-\text{CH}_{50} \\   \\ \text{COOC}_2\text{H}_5 \end{array}$					

No.	Hydrophobic polymer	Inorganic particles (weight % relative to hydrophobic polymer)	Metal alkoxide compound (weight % relative to hydrophobic polymer)	Dispersing agent (weight % relative to hydrophobic polymer)	
				SP-4 (200)	ST-16 (5)
PL-11	$\left( \text{CH}_2 - \overset{\text{CH}_3}{\underset{\text{COO}-\text{C}_6\text{H}_4}{\text{C}}} \right)_{80} - \overset{\text{CH}_3}{\underset{\text{COOCH}_2\text{CH}_2\text{OH}}{\text{C}}} \text{H}_2 - \overset{\text{CH}_3}{\underset{\text{COOCH}_2\text{CH}_2\text{OH}}{\text{C}}} \right)_{20}$	SP-4 (200)	ST-16 (5)	SP-6 (10)	
PL-12	$\left( \text{CH}_2 - \overset{\text{CH}_3}{\underset{\text{COO}-\text{C}_6\text{H}_4}{\text{C}}} \right)_{60} - \overset{\text{CH}_3}{\underset{\text{COO}(\text{I})\text{C}_9\text{H}_{19}}{\text{C}}} \text{H}_2 - \overset{\text{CH}_3}{\underset{\text{COOCH}_2\text{CH}_2\text{OCH}_2}{\text{C}}} \right)_{30}$	SP-1 (200)	ST-16 (1)	SP-3 (10)	
PL-13	$\left( \text{CH}_2 - \overset{\text{CH}_3}{\underset{\text{COO}(\text{I})\text{C}_9\text{H}_{19}}{\text{C}}} \right)_{80} - \overset{\text{CH}_3}{\underset{\text{COOCH}_3}{\text{C}}} \text{H}_2 - \overset{\text{CH}_3}{\underset{\text{COOCH}_3}{\text{C}}} \right)_{20}$	SP-20 (100)	—	SP-1 (10)	

No.	Hydrophobic polymer	Inorganic particles (weight % relative to hydrophobic polymer)	Metal alkoxide compound (weight % relative to hydrophobic polymer)	Dispersing agent (weight % relative to hydrophobic polymer)
PL-14	$\text{--CH}_2\text{--CH}_{\frac{1}{100}}$ OCOCH <sub>3</sub>	S0-1 (300)	—	SP-3 (10)
PL-15	$\text{--CH}_2\text{--CH}_{\frac{1}{50}}$ OCOCH <sub>3</sub>	S0-1 (300)	—	SP-3 (10)
PL-16	$\text{--CH}_2\text{--CH}_{\frac{1}{25}}$ OCOCH <sub>3</sub>	S0-1 (300)	—	SP-3 (10)
PL-17	$\text{--CH}_2\text{--CH}_{\frac{1}{30}}$ OCOCH <sub>2</sub> CH <sub>3</sub>	S0-1 (300)	—	SP-3 (10)
PL-18	$\text{--CH}_2\text{--CH}_{\frac{1}{30}}$ OCOCH <sub>2</sub> CH <sub>3</sub>	S0-1 (300)	ST-16 (1)	SP-3 (10)

No.	Hydrophobic polymer	Inorganic particles (weight % relative to hydrophobic polymer)	Metal alkoxide compound (weight % relative to hydrophobic polymer)	Dispersing agent (weight % relative to hydrophobic polymer)
PL-19	$\overline{-\text{CH}_2-\text{CH}-}_{30}$ $\text{OCO}(\text{CH}_2)_2\text{CH}_3$	$\overline{-\text{CH}_2-\text{CH}-}_{70}$ $\text{OCO(tBu)}$	S0-1 (300)	— SP-3 (10)
PL-20	$\overline{-\text{CH}_2-\text{CH}-}_{26}$ $\text{OCO}(\text{CH}_2)_6\text{CH}_3$	$\overline{-\text{CH}_2-\text{CH}-}_{74}$ $\text{OCO(iBu)}$	S0-1 (300)	— SP-3 (10)

As for the specific production methods of the composite latex, Preparation Examples 1 to 3 described later can be referred to.

In the present invention, the acrylic acid ester resin 5 composite polymers, VONCOAT DV series produced by Dainippon Ink, Inc. and so forth can also be preferably used as commercially available composite latex.

Although the composite latex may be added by an arbitrary method, it is preferably dissolved in water or a hydrophilic 10 solvent and added to an emulsion after chemical ripening.

The composite latex comprising inorganic particles and hydrophobic polymer is added to one or more silver halide emulsions layers or hydrophilic colloid layers on the side of silver halide emulsion layers with respect to the support. The 15 composite latex is particularly preferably contained in at least one silver halide emulsion layer.

There are no particular limitations on various additives used in the silver halide photographic light-sensitive material of the present invention, and there are mentioned, for example, 20 those described below.

That is, there are mentioned, for example, those described below can be used: polyhydroxybenzene compounds described in JP-A-3-39948, page 10, right lower column, line 11 to page 12, left lower column, line 5, specifically, Compounds 25 (III)-1 to (III)-25 described in the same; compounds that substantially do not have an absorption maximum in the visible region represented by the formula (I) described in JP-A-1-

118832, specifically, Compounds I-1 to I-26 described in the same; antifoggants described in JP-A-2-103536, page 17, right lower column, line 19 to page 18, right upper column, line 4; polymer latexes described in JP-A-2-103536, page 18, left lower column, line 12 to line 20, polymer latexes having an active 5 methylene group represented by formula (I) described in JP-A-9-179228, specifically, Compounds I-1 to I-16 described in the same, polymer latexes having a core/shell structure described in JP-A-9-179228, specifically, Compounds P-1 to P-55 described 10 in the same, and acidic polymer latexes described in JP-A-7-104413, page 14, left column, line 1 to right column, line 30, specifically, Compounds II-1) to II-9) described on page 15 of the same; matting agents, lubricants and plasticizers described in JP-A-2-103536, page 19, left upper column, line 15 to right 15 upper column, line 15; hardening agents described in JP-A-2-103536, page 18, right upper column, line 5 to line 17; compounds having an acid radical described in JP-A-2-103536, page 18, right lower column, line 6 to page 19, left upper column, line 1; conductive materials described in JP-A-2-18542, 20 page 2, left lower column, line 13 to page 3, right upper column, line 7, specifically, metal oxides described in page 2, right lower column, line 2 to line 10 of the same, and conductive polymer compounds P-1 to P-7 described in the same; water-soluble dyes described in JP-A-2-103536, page 17, right 25 lower column, line 1 to line 18; solid dispersion dyes represented by the formulas (FA), (FA1), (FA2) and (FA3) described in JP-A-7-179243, specifically, Compounds F1 to F34

described in the same; Compounds (II-2) to (II-24), Compounds (III-5) to (III-18) and Compounds (IV-2) to (IV-7) described in JP-A-7-152112, and solid dispersion dyes described in JP-A-2-294638 and JP-A-5-11382; surfactants described in JP-A-2-12236, 5 page 9, upper right column, line 7 to lower right column, line 3, PEG type surfactants described in JP-A-2-103536, page 18, lower left column, lines 4 to 7, fluorine-containing surfactants described in JP-A-3-39948, page 12, lower left column, line 6 to page 13, lower right column, line 5, 10 specifically Compounds I-1 to I-15 described in the same; redox compounds capable of releasing a development inhibitor by oxidation described in JP-A-5-274816, preferably redox compounds represented by the formulas (R-1), (R-2) and (R-3) described in the same, specifically, Compounds R-1 to R-68 15 described in the same; and binders described in JP-A-2-18542, page 3, right lower column, line 1 to line 20.

The silver halide photographic light-sensitive material of the present invention is preferably developed in the presence of a benzotriazole compound. Although the 20 benzotriazole compound may be generally added to the light-sensitive material or developer, it is preferably added to the light-sensitive material. When the benzotriazole compound is added to the light-sensitive material, it may be added to the silver halide emulsion layer side or the side opposite to the 25 silver halide emulsion layer side with respect to the support. It is preferably added to the silver halide emulsion layer side, particularly preferably added to the silver halide emulsion

layer.

Although the benzotriazole compound used for the present invention may have any structure, those mentioned below are preferred.

- 5 (1) 5,6-Dimethylbenzotriazole
- (2) 5-Butylbenzotriazole
- (3) 5-Methylbenzotriazole
- (4) 5-Chlorobenzotriazole
- (5) 5-Bromobenzotriazole
- 10 (6) 5,6-Dichlorobenzotriazole
- (7) 4,6-Dichlorobenzotriazole
- (8) 5-Nitrobenzotriazole
- (9) 4-Nitro-6-chlorobenzotriazole
- (10) 4,5,6-trichlorobenzotriazole
- 15 (11) 5-Carboxybenzotriazole
- (12) 5-Sulfonylbenzotriazole
- (13) 5-Methoxycarbonylbenzotriazole
- (14) 5-Aminobenzotriazole
- (15) 5-Butoxybenzotriazole
- 20 (16) 5-Ureidobenzotriazole
- (17) Benzotriazole

The particularly preferred benzotriazole compounds used for the present invention are benzotriazole and 5-methylbenzotriazole.

25 The amount of the benzotriazole compound used for the present invention is, in the case of the silver halide photographic light-sensitive material, preferably  $1 \times 10^{-4}$  to 1

$\times 10^{-1}$  mol/mol of silver halide, particularly preferably  $1 \times 10^{-3}$  to  $7 \times 10^{-2}$  mol/mol of silver halide.

When it is added to the developer, it is preferably  $7.5 \times 10^{-5}$  to  $7.5 \times 10^{-3}$  mol/liter, particularly preferably  $7.5 \times 10^{-5}$  to  $5.0 \times 10^{-3}$  mol/liter.

Further, two or more kinds of benzotriazole compounds may be used together, or addition to the silver halide photographic light-sensitive material and addition to the developer may be used in combination.

Processing chemicals such as developing solution (developer) and fixing solution (fixer) and processing methods that can be used for the silver halide photographic light-sensitive material according to the present invention are described below, but of course the present invention should not be construed as being limited to the following description and specific examples.

For the development of the silver halide photographic light-sensitive material of the present invention, any of known methods can be used, and known developers can be used.

A developing agent for use in developer (hereinafter, starter developer and replenisher developer are collectively referred to as developer) used for the present invention is not particularly limited, but it is preferable to add dihydroxybenzenes, ascorbic acid derivatives or hydroquinonemonosulfonates, and they can be used each alone or in combination. In particular, a dihydroxybenzene type developing agent and an auxiliary developing agent exhibiting

superadditivity are preferably contained in combination, and combinations of a dihydroxybenzene compound or an ascorbic acid derivative with a 1-phenyl-3-pyrazolidone compound, or combinations of a dihydroxybenzene compound or ascorbic acid

5 compound with a p-aminophenol compound can be mentioned.

Examples of the dihydroxybenzene developing agent as a developing agent used for the present invention includes hydroquinone, chlorohydroquinone, isopropylhydroquinone, methylhydroquinone and so forth, and hydroquinone is particularly preferred. Examples of the ascorbic acid derivative developing agent include ascorbic acid, isoascorbic acid and salts thereof. Sodium erythorbate is particularly preferred in view of material cost.

10 Examples of the 1-phenyl-3-pyrazolidones or derivatives thereof as the developing agent used for the present invention include 1-phenyl-3-pyrazolidone, 1-phenyl-4,4-dimethyl-3-pyrazolidone, 1-phenyl-4-methyl-4-hydroxymethyl-3-pyrazolidone and so forth.

15 Examples of the p-aminophenol type developing agent used for the present invention include N-methyl-p-aminophenol, p-aminophenol, N-( $\beta$ -hydroxyphenyl)-p-aminophenol, N-(4-hydroxyphenyl)glycine, o-methoxy-p-(N,N-dimethylamino)phenol, o-methoxy-p-(N-methylamino)phenol etc., and N-methyl-p-aminophenol and aminophenols described in JP-A-9-297377 and JP-25 A-9-297378 are preferred.

20 The dihydroxybenzene type developing agent is preferably used in an amount of generally 0.05 to 0.8 mol/L. When a

dihydroxybenzene compound and a 1-phenyl-3-pyrazolidone compound or a p-aminophenol compound are used in combination, the former is preferably used in an amount of 0.05 to 0.6 mol/L, more preferably 0.10 to 0.5 mol/L, and the latter is preferably used in an amount of 0.06 mol/L or less, more preferably 0.003 to 0.03 mol/L.

5       The ascorbic acid derivative developing agent is preferably used in an amount of generally 0.01 to 0.5 mol/L, more preferably 0.05 to 0.3 mol/L. When an ascorbic acid 10      derivative and a 1-phenyl-3-pyrazolidone compound or a p-aminophenol compound are used in combination, the ascorbic acid derivative is preferably used in an amount of from 0.01 to 0.5 mol/L, and the 1-phenyl-3-pyrazolidone compound or p-aminophenol compound is preferably used in an amount of 0.005 15      to 0.2 mol/L.

      The developer used in processing the silver halide photographic light-sensitive material of the present invention may contain usually used additives (e.g., a developing agent, alkali agent, pH buffer, preservative, chelating agent etc.). 20      Specific examples thereof are described below, but the present invention is by no means limited to them.

      Examples of the buffer for use in the developer used in development of the light-sensitive material according to the present invention include carbonates, boric acids described in 25      JP-A-62-186259, saccharides (e.g., saccharose) described in JP-A-60-93433, oximes (e.g., acetoxime), phenols (e.g., 5-sulfosalicylic acid), tertiary phosphates (e.g., sodium salt

and potassium salt) etc., and carbonates are preferably used. The buffer, in particular the carbonate, is preferably used in an amount of 0.05 mol/L or more, particularly preferably 0.08 to 1.0 mol/L.

5 Examples of the preservative used for the present invention include sodium sulfite, potassium sulfite, lithium sulfite, ammonium sulfite, sodium bisulfite, sodium methabisulfite, formaldehyde-sodium bisulfite and so forth. The sulfites are used in an amount of preferably 0.2 mol/L or more, 10 particularly preferably 0.3 mol/L or more. However, if it is added in an unduly large amount, silver staining in the developer is caused. Accordingly, the upper limit is preferably 1.2 mol/L. The amount is particularly preferably 0.35 to 0.7 mol/L.

15 As the preservative for a dihydroxybenzene type developing agent, a small amount of the aforementioned ascorbic acid derivative may be used together with the sulfite. Sodium erythorbate is particularly preferably used in view of material cost. It is preferably added in an amount of 0.03 to 0.12, 20 particularly preferably 0.05 to 0.10, in terms of molar ratio with respect to the dihydroxybenzene type developing agent. When an ascorbic acid derivative is used as the preservative, the developer preferably does not contain a boron compound.

Examples of additives to be used other than those 25 described above include a development inhibitor such as sodium bromide and potassium bromide, an organic solvent such as ethylene glycol, diethylene glycol, triethylene glycol and

dimethylformamide, a development accelerator such as an alkanolamine including diethanolamine, triethanolamine etc. and an imidazole and derivatives thereof, and an agent for preventing uneven physical development such as a heterocyclic

5 mercapto compound (e.g., sodium 3-(5-mercaptotetrazol-1-yl)benzenesulfonate, 1-phenyl-5-mercaptotetrazole etc.) and the compounds described in JP-A-62-212651.

Further, a mercapto compound, indazole compound or benzimidazole compound may be added as an antifoggant or a 10 black spot (black pepper) inhibitor. Specific examples thereof include 5-nitroindazole, 5-p-nitrobenzoylaminoindazole, 1-methyl-5-nitroindazole, 6-nitroindazole, 3-methyl-5-nitroindazole, 5-nitrobenzimidazole, 2-isopropyl-5-nitrobenzimidazole, 5-nitrobenzotriazole, sodium 4-((2-15 mercapto-1,3,4-thiadiazol-2-yl)thio)butanesulfonate, 5-amino-1,3,4-thiadiazole-2-thiol and so forth. The addition amount thereof is generally 0.01 to 10 mmol, preferably 0.1 to 2 mmol, per liter of the developer.

Further, various kinds of organic or inorganic chelating 20 agents can be used individually or in combination in the developer used for the present invention.

As the inorganic chelating agents, sodium tetrapolyphosphate, sodium hexametaphosphate and so forth can be used.

25 As the organic chelating agents, organic carboxylic acid, aminopolycarboxylic acid, organic phosphonic acid, aminophosphonic acid and organic phosphonocarboxylic acid can

be mainly used.

Examples of the organic carboxylic acid include acrylic acid, oxalic acid, malonic acid, succinic acid, glutaric acid, gluconic acid, adipic acid, pimelic acid, azelaic acid, sebacic acid, 5 nonanedicarboxylic acid, decanedicarboxylic acid, undecanedicarboxylic acid, maleic acid, itaconic acid, malic acid, citric acid, tartaric acid etc.

Examples of the aminopolycarboxylic acid include iminodiacetic acid, nitrilotriacetic acid, nitrilotripropionic acid, 10 ethylenediaminemonohydroxyethyltriacetic acid, ethylenediaminetetraacetic acid, glycol ether-tetraacetic acid, 1,2-diaminopropanetetraacetic acid, diethylenetriaminepentaacetic acid, triethylenetetraminehexaacetic acid, 1,3-diamino-2- 15 propanoltetraacetic acid, glycol ether-diaminetetraacetic acid, and compounds described in JP-A-52-25632, JP-A-55-67747, JP-A- 57-102624 and JP-B-53-40900.

Examples of the organic phosphonic acid include hydroxyalkylidene-diphosphonic acids described in U.S. Patent 20 Nos. 3,214,454, 3,794,591 and West German Patent Publication No. 2,227,369, and the compounds described in Research Disclosure, Vol. 181, Item 18170 (May, 1979) and so forth.

Examples of the aminophosphonic acid include amino- 25 tris(methylenephosphonic acid), ethylenediaminetetramethylenephosphonic acid, aminotrimethylenephosphonic acid and so forth, and the compounds described in Research Disclosure, No. 18170 (supra),

JP-A-57-208554, JP-A-54-61125, JP-A-55-29883, JP-A-56-97347 and so forth can also be mentioned.

Examples of the organic phosphonocarboxylic acid include the compounds described in JP-A-52-102726, JP-A-53-42730, JP-A-5 54-121127, JP-A-55-4024, JP-A-55-4025, JP-A-55-126241, JP-A-55-65955, JP-A-55-65956, Research Disclosure, No. 18170 (supra) and so forth.

Among these chelating agents, diethylenetriamines are particularly preferred. Among the diethylenetriamines, 10 diethylenetriaminepentaacetic acid and metal salts thereof are particularly preferred.

The organic and/or inorganic chelating agents are not limited to those described above. The organic and/or inorganic chelating agents may be used in the form of an alkali metal 15 salt or an ammonium salt. The amount of the chelating agent is preferably  $1 \times 10^{-4}$  to  $1 \times 10^{-1}$  mol, more preferably  $1 \times 10^{-3}$  to  $1 \times 10^{-2}$  mol, per liter of the developer.

Further, a silver stain inhibitor may be added to the developer, and examples thereof include, for example, the 20 compounds described in JP-A-56-24347, JP-B-56-46585, JP-B-62-2849, JP-A-4-362942 and JP-A-8-6215; triazines having one or more mercapto groups (for example, the compounds described in JP-B-6-23830, JP-A-3-282457 and JP-A-7-175178); pyrimidines having one or more mercapto groups (e.g., 2-mercaptopyrimidine, 25 2,6-dimercaptopyrimidine, 2,4-dimercaptopyrimidine, 5,6-diamino-2,4-dimercaptopyrimidine, 2,4,6-trimercaptopyrimidine, the compounds described in JP-A-9-274289 etc.); pyridines

having one or more mercapto groups (e.g., 2-mercaptopypyridine, 2,6-dimercaptopypyridine, 3,5-dimercaptopypyridine, 2,4,6-trimercaptopypyridine, compounds described in JP-A-7-248587 etc.); pyrazines having one or more mercapto groups (e.g., 2-5 mercaptopyrazine, 2,6-dimercaptopyrazine, 2,3-dimercaptopyrazine, 2,3,5-trimercaptopyrazine etc.); pyridazines having one or more mercapto groups (e.g., 3-mercaptopypyridazine, 3,4-dimercaptopyridazine, 3,5-dimercaptopyridazine, 3,4,6-trimercaptopyridazine etc.); the 10 compounds described in JP-A-7-175177, polyoxyalkylphosphonic acid esters described in U.S. Patent No. 5,457,011 and so forth. These silver stain inhibitors may be used individually or in combination of two or more of these. The addition amount thereof is preferably 0.05 to 10 mmol, more preferably 0.1 to 5 15 mmol, per liter of the developer.

The developer may also contain the compounds described in JP-A-61-267759 as a dissolution aid.

Further, the developer may also contain a toning agent, surfactant, defoaming agent, hardening agent or the like, if 20 necessary.

The developer preferably has a pH of 9.0 to 11.0, more preferably 9.2 to 11.0, particularly preferably 9.5 to 11.0. The alkali agent used for adjusting pH may be a usual water-soluble inorganic alkali metal salt (e.g., sodium hydroxide, 25 potassium hydroxide, sodium carbonate, potassium carbonate etc.).

It is preferred that the developer exhibits pH increase

of 0.4 or more, preferably 0.4 to 1.0, when 0.1 mol of sodium hydroxide is added to 1 L of the developer.

As for the cation of the developer, potassium ion less inhibits development and causes less indentations, called 5 fringes, on peripheries of blackened portions, compared with sodium ion. Further, when the developer is stored as a concentrated solution, a potassium salt shows higher solubility, and thus potassium salt is generally preferred. However, since, in the fixer, potassium ion causes fixing inhibition on the 10 same level as silver ion, a high potassium ion concentration in the developer disadvantageously causes increase of the potassium ion concentration in the fixer due to carrying over of the developer by the light-sensitive material. In view of the above, the molar ratio of potassium ion to sodium ion in 15 the developer is preferably between 20:80 and 80:20. The ratio of potassium ion to sodium ion can be freely controlled within the above-described range by a counter cation such as those derived from a pH buffer, pH adjusting agent, preservative, chelating agent or the like.

20 The replenishing amount of the developer is generally 323 mL or less, preferably 30 to 323 mL, most preferably 120 to 323 mL, per  $m^2$  of the light-sensitive material. The replenisher developer may have the same composition and/or concentration as those of the starter developer, or it may have a different 25 composition and/or concentration from those of the starter developer.

Examples of the fixing agent in the fixing processing

agent that can be used for the present invention include ammonium thiosulfate, sodium thiosulfate and ammonium sodium thiosulfate. The amount of the fixing agent may be varied appropriately, but it is generally about 0.7 to 3.0 mol/L.

5       The fixer used for the present invention may contain a water-soluble aluminum salt or a water-soluble chromium salt, which acts as a hardening agent, and among these salts, a water-soluble aluminum salt is preferred. Examples thereof include aluminum chloride, aluminum sulfate, potassium alum, 10 ammonium aluminum sulfate, aluminum nitrate, aluminum lactate and so forth. These are preferably contained in an amount of 0.01 to 0.15 mol/L in terms of aluminum ion concentration in the solution used.

When the fixer is stored as a concentrated solution or a 15 solid agent, it may be constituted by a plurality of parts including a hardening agent or the like as a separate part, or it may be constituted as a one-part agent containing all components.

The fixing processing agent may contain, if desired, a 20 preservative (e.g., sulfite, bisulfite, metabisulfite etc. in an amount of 0.015 mol/L or more, preferably 0.02 to 0.3 mol/L), pH buffer (e.g., acetic acid, sodium acetate, sodium carbonate, sodium hydrogencarbonate, phosphoric acid, succinic acid, adipic acid etc. in an amount of generally 0.1 to 1 mol/L, 25 preferably 0.2 to 0.7 mol/L), and a compound having aluminum-stabilizing ability or hard water-softening ability (e.g., gluconic acid, iminodiacetic acid, 5-sulfosalicylic acid,

glucoheptanoic acid, malic acid, tartaric acid, citric acid, oxalic acid, maleic acid, glycolic acid, benzoic acid, salicylic acid, Tiron, ascorbic acid, glutaric acid, aspartic acid, glycine, cysteine, ethylenediaminetetraacetic acid, 5 nitrilotriacetic acid, derivatives and salts thereof, saccharides etc. in an amount of 0.001 to 0.5 mol/L, preferably 0.005 to 0.3 mol/L). However, in view of environmental protection recently concerned, it is preferred that a boron compound is not contained.

10 In addition, the fixing processing agent may contain a compound described in JP-A-62-78551, pH adjusting agent (e.g., sodium hydroxide, ammonia, sulfuric acid etc.), surfactant, wetting agent, fixing accelerator etc. Examples of the surfactant include anionic surfactants such as sulfated 15 products and sulfonated products, polyethylene surfactants and amphoteric surfactants described in JP-A-57-6840. Known deforming agents may also be used. Examples of the wetting agent include alkanolamines and alkylene glycols. Examples of the fixing accelerator include alkyl- or aryl-substituted 20 thiosulfonic acids and salts thereof described in JP-A-6-308681; thiourea derivatives described in JP-B-45-35754, JP-B-58-122535 and JP-B-58-122536; alcohols having a triple bond within the molecule; thioether compounds described in U.S. Patent No. 4,126,459; mercapto compounds described in JP-A-64-25 4739, JP-A-1-4739, JP-A-1-159645 and JP-A-3-101728; mesoionic compounds and thiocyanates described in JP-A-4-170539.

pH of the fixer used for the present invention is

preferably 4.0 or more, more preferably 4.5 to 6.0. pH of the fixer rises with processing by the contamination of developer. In such a case, pH of a hardening fixer is preferably 6.0 or less, more preferably 5.7 or less, and that of a non-hardening 5 fixer is preferably 7.0 or less, more preferably 6.7 or less.

The replenishing rate of the fixer is preferably 500 mL or less, more preferably 390 mL or less, still more preferably 320 to 80 mL, per  $m^2$  of the light-sensitive material. The composition and/or the concentration of the replenisher fixer 10 may be the same as or different from those of the starter fixer.

The fixer can be reclaimed for reuse according to known fixer reclaiming methods such as electrolytic silver recovery. As reclaiming apparatuses, there are FS-2000 produced by Fuji Photo Film Co., Ltd. and so forth.

15 Further, removal of dyes and so forth using an adsorptive filter such as those comprising activated carbon is also preferred.

When the developing and fixing processing chemicals used in the present invention are solutions, they are preferably 20 preserved in packaging materials of low oxygen permeability as disclosed in JP-A-61-73147. Further, when these solutions are concentrated solutions, they are diluted with water to a predetermined concentration in the ratio of 0.2 to 3 parts of water to one part of the concentrated solutions.

25 Even if the developing processing chemicals and fixing processing chemicals used in the present invention are made as solids, the same effects as solutions can be obtained. In view

of storage stability, solid processing chemicals are more preferred. Solid processing chemicals are described below.

Solid chemicals that can be used for the present invention may be made into known shapes such as powders, 5 granular powders, granules, lumps, tablets, compactors, briquettes, plates, bars, paste or the like. These solid chemicals may be covered with water-soluble coating agents or films to separate components that react with each other on contact, or they may have a multilayer structure to separate 10 components that react with each other, or both types may be used in combination.

Although known coating agents and auxiliary granulating agents can be used, polyvinylpyrrolidone, polyethylene glycol, polystyrenesulfonic acid and vinyl compounds are preferably 15 used. Further, JP-A-5-45805, column 2, line 48 to column 3, line 13 can be referred to.

When a multilayer structure is used, components that do not react with each other on contact may be sandwiched with components that react with each other and made into tablets, 20 briquettes or the like, or components of known shapes may be made into a similar layer structure and packaged. Methods therefor are disclosed in JP-A-61-259921, JP-A-4-16841, JP-A-4-78848, JP-A-5-93991 and so forth.

The bulk density of the solid processing chemicals is 25 preferably 0.5 to 6.0 g/cm<sup>3</sup>, in particular, the bulk density of tablets is preferably 1.0 to 5.0 g/cm<sup>3</sup>, and that of granules is preferably 0.5 to 1.5 g/cm<sup>3</sup>.

Solid processing chemicals used for the present invention can be produced by using any known method, and one can refer to, for example, JP-A-61-259921, JP-A-4-15641, JP-A-4-16841, JP-A-4-32837, JP-A-4-78848, JP-A-5-93991, JP-A-4-85533, JP-A-4-85534, 5 JP-A-4-85535, JP-A-5-134362, JP-A-5-197070, JP-A-5-204098, JP-A-5-224361, JP-A-6-138604, JP-A-6-138605, JP-A-8-286329 and so forth.

More specifically, the rolling granulating method, extrusion granulating method, compression granulating method, 10 cracking granulating method, stirring granulating method, spray drying method, dissolution coagulation method, briquetting method, roller compacting method and so forth can be used.

The solubility of the solid chemicals used in the present invention can be adjusted by changing state of surface (smooth, 15 porous, etc.) or partially changing the thickness, or making the shape into a hollow doughnut shape. Further, it is also possible to provide different solubilities to a plurality of granulated products, or it is also possible for materials having different solubilities to use various shapes to obtain 20 the same solubilities. Multilayer granulated products having different compositions between the inside and the surface can also be used.

Packaging materials of solid chemicals preferably have low oxygen and water permeabilities, and those of known shapes 25 such as bag-like, cylindrical and box-like shapes can be used. Packaging materials of foldable shapes are preferred for saving storage space of waste packaging materials as disclosed in JP-

A-6-242585 to JP-A-6-242588, JP-A-6-247432, JP-A-6-247448, JP-A-6-301189, JP-A-7-5664, and JP-A-7-5666 to JP-A-7-5669.

Takeout ports of processing chemicals of these packaging materials may be provided with a screw cap, pull-top or 5 aluminum seal, or packaging materials may be heat-sealed, or other known types may be used, and there are no particular limitations. Waste packaging materials are preferably recycled or reused in view of environmental protection.

Methods of dissolution and replenishment of the solid 10 processing chemicals used for the present invention are not particularly limited, and known methods can be used. Examples of these known methods include a method in which a certain amount of processing chemicals are dissolved and replenished by a dissolving apparatus having a stirring function, a method in 15 which processing chemicals are dissolved by a dissolving apparatus having a dissolving zone and a zone where a finished solution is stocked and the solution is replenished from the stock zone as disclosed in JP-A-9-80718, and methods in which processing chemicals are fed to a circulating system of an 20 automatic processor and dissolved and replenished, or processing chemicals are fed to a dissolving tank provided in an automatic processor with progress of the processing of light-sensitive materials as disclosed in JP-A-5-119454, JP-A-6-19102 and JP-A-7-261357. In addition to the above methods, 25 any of known methods can be used. The charge of processing chemicals may be conducted manually, or automatic opening and automatic charge may be conducted by using a dissolving

apparatus or automatic processor provided with an opening mechanism as disclosed in JP-A-9-138495. The latter is preferred in view of the working environment. Specifically, there are methods of pushing through, unsealing, cutting off 5 and bursting a takeout port of package, methods disclosed in JP-A-6-19102 and JP-A-6-95331 and so forth.

The light-sensitive material is subjected to washing or stabilizing processing after being developed and fixed (hereinafter washing includes stabilization processing, and a 10 solution used therefor is called water or washing water unless otherwise indicated). The water used for washing may be any of tap water, ion exchange water, distilled water and stabilized solution. The replenishing rate therefor is, in general, about 8 to 17 liters per  $m^2$  of the light-sensitive material, but 15 washing can be carried out with a replenishing rate less than the above. In particular, with a replenishing rate of 3 liters or less (including zero, i.e., washing in a reservoir), not only water saving processing can be carried out, but also piping for installation of an automatic processor becomes 20 unnecessary. When washing is carried out with a reduced replenishing amount of water, it is more preferable to use a washing tank equipped with a squeegee roller or a crossover roller disclosed in JP-A-63-18350, JP-A-62-287252 or the like. The addition of various kinds of oxidizing agents (e.g., ozone, 25 hydrogen peroxide, sodium hypochlorite, activated halogen, chlorine dioxide, sodium carbonate hydrogen peroxide salt etc.) and filtration through filters may be combined to reduce load

on environmental pollution which becomes a problem when washing is carried out with a small amount of water and to prevent generation of scale.

As a method of reducing the replenishing amount of the 5 washing water, a multistage countercurrent system (e.g., two stages or three stages) has been known for a long time. The replenishing amount of the washing water in this system is preferably 50 to 200 mL per  $m^2$  of the light-sensitive material. This effect can also similarly be obtained in an independent 10 multistage system (a method in which a countercurrent is not used and fresh solution is separately replenished to multistage washing tanks).

Further, means for preventing generation of scale may be included in a washing step used for the present invention. 15 Means for preventing generation of scale is not particularly limited, and known means can be used. There are, for example, a method of adding an antifungal agent (so-called scale preventive), a method of using electroconduction, a method of irradiating ultraviolet ray, infrared ray or far infrared ray, 20 a method of applying a magnetic field, a method of using ultrasonic wave processing, a method of applying heat, a method of emptying tanks when they are not used and so forth. These scale preventing means may be used with progress of the processing of light-sensitive materials, may be used at regular 25 intervals irrespective of usage conditions, or may be conducted only during the time when processing is not conducted, for example, during night. In addition, washing water previously

subjected to a treatment with such means may be replenished. It is also preferable to use different scale preventing means for every given period of time for inhibiting proliferation of resistant fungi.

5       As a water-saving and scale-preventing apparatus, an apparatus AC-1000 produced by Fuji Photo Film Co., Ltd. and a scale-preventing agent AB-5 produced by Fuji Photo Film Co., Ltd. may be used, and the method disclosed in JP-A-11-231485 may also be used.

10      The antifungal agent is not particularly restricted, and a known antifungal agent may be used. Examples thereof include, in addition to the above-described oxidizing agents, glutaraldehyde, chelating agent such as aminopolycarboxylic acid, cationic surfactant, mercaptopyridine oxide (e.g., 2-mercaptopyridine-N-oxide) and so forth, and a sole antifungal agent may be used, or a plurality of antifungal agents may be used in combination.

15      The electricity may be applied according to the methods described in JP-A-3-224685, JP-A-3-224687, JP-A-4-16280, JP-A-20 4-18980 and so forth.

20      In addition, a known water-soluble surfactant or defoaming agent may be added so as to prevent uneven processing due to bubbling, or to prevent transfer of stains. Further, the dye adsorbent described in JP-A-63-163456 may be provided in 25 the washing with water system, so as to prevent stains due to a dye dissolved out from the light-sensitive material.

Overflow solution from the washing with water step may be

partly or wholly used by mixing it with the processing solution having fixing ability, as described in JP-A-60-235133. In view of protection of the natural environment, it is also preferable to reduce the biochemical oxygen demand (BOD), chemical oxygen demand (COD), iodine consumption or the like in waste water before discharge by subjecting the solution to microbial treatment (for example, activated sludge treatment, treatment with a filter comprising a porous carrier such as activated carbon or ceramic carrying microorganisms such as sulfur-oxidizing bacteria etc.) or oxidation treatment with electrification or an oxidizing agent before discharge, or to reduce the silver concentration in waste water by passing the solution through a filter using a polymer having affinity for silver, or by adding a compound that forms a hardly soluble silver complex, such as trimercaptotriazine, to precipitate silver, and then passing the solution through a filter.

In some cases, stabilization may be performed after the washing with water, and as an example thereof, a bath containing the compounds described in JP-A-2-201357, JP-A-2-132435, JP-A-1-102553 and JP-A-46-44446 may be used as a final bath of the light-sensitive material. This stabilization bath may also contain, as required, an ammonium compound, metal compound such as Bi or Al, fluorescent brightening agent, various chelating agents, layer pH-adjusting agent, hardening agent, bactericide, antifungal agent, alkanolamine or surfactant.

The additives such as antifungal agent and the

stabilizing agent added to the washing with water or stabilization bath may be formed into a solid agent like the aforementioned developing and fixing processing agents.

Waste solutions of the developer, fixer, washing water or 5 stabilizing solution used for the present invention are preferably burned for disposal. The waste solutions can also be concentrated or solidified by concentration by using a concentrating apparatus such as those described in JP-B-7-83867 and U.S. Patent No. 5,439,560, and then disposed.

10 When the replenishing amounts of the processing agents are reduced, it is preferable to prevent evaporation or air oxidation of the solution by reducing the opening area of the processing tank. A roller transportation-type automatic processor is described in, for example, U.S. Patent Nos. 15 3,025,779 and 3,545,971, and in the present specification, it is simply referred to as a roller transportation-type automatic processor. This automatic processor performs four steps of development, fixing, washing with water and drying, and it is most preferable to follow this four-step processing also in the 20 present invention, although other steps (e.g., stopping step) are not excluded. Further, a rinsing bath (tank for washing) may be provided between development and fixing and/or between fixing and washing with water.

In the development of the silver halide photographic 25 light-sensitive material of the present invention, the dry-to-dry time from the start of processing to finish of drying is preferably 25 to 160 seconds, the development time and the

fixing time are each generally 40 seconds or less, preferably 6 to 35 seconds, and the temperature of each solution is preferably 25 to 50°C, more preferably 30 to 40°C. The temperature and the time of washing with water are preferably 0 5 to 50°C and 40 seconds or less, respectively. According to such a method, the light-sensitive material after development, fixing and washing with water may be passed between squeeze rollers for squeezing washing water, and then dried. The drying is generally performed at a temperature of about 40°C to about 10 100°C. The drying time may be appropriately varied depending on the ambient conditions. The drying method is not particularly limited, and any known method may be used. Hot-air drying and drying by a heat roller or far infrared rays as described in JP-A-4-15534, JP-A-5-2256 and JP-A-5-289294 may be used, and a 15 plurality of drying methods may also be used in combination.

As the image setter and automatic processor used for the present invention, any combination of them may be used so long as any problem is not caused concerning transportation. As the image setter, any of F9000 and Lux Setter RC-5600V produced by 20 Fuji Photo Film Co., Ltd, Image setter FT-R5055 produced by Dainippon Screen Mfg. Co., Ltd., Select Set 5000, Avantra 25 and Acuset 1000 produced by Agfa Gevaert AG, Dolev 450 and Dolev 800 produced by Scitex, Lino 630, Quasar, Herkules ELITE and Signasetter produced by Heidelberg Co., Luxel F-9000, and 25 Panther Pro 62 produced by PrePRESS Inc. may be used.

#### EXAMPLES

The present invention will be specifically explained with reference to the following examples and comparative examples.

The materials, amounts, ratios, types and procedures of processes and so forth shown in the following examples can be

5 optionally changed so long as such change does not depart from the spirit of the present invention. Therefore, the scope of the present invention should not be construed in any limitative way based on the following examples.

10 <Preparation Example 1>

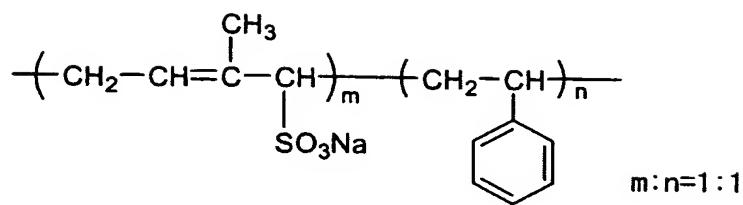
Preparation of Composite latex L-1

In a volume of 360 mL of distilled water and 126 g of 30 weight % colloidal silica dispersion were introduced into a 1000-mL 4-neck flask attached with a stirrer, thermometer,

15 dropping funnel, nitrogen inlet pipe and reflux condenser and heated until the internal temperature became 80°C, while

nitrogen gas was introduced to purge oxygen. To the reaction mixture, 1.3 g of the following compound was added, 0.023 g of ammonium persulfate was added as an initiator, then 12.6 g of

20 vinyl pivalate was added, and the reaction was allowed for 4 hours. Thereafter, the reaction mixture was cooled and adjusted to pH 6 with a sodium hydroxide solution to obtain Composite latex L-1.



<Preparation Example 2>

Preparation of Composite latex L-2

In a volume of 360 mL of distilled water and 126 g of 30 weight % colloidal silica dispersion were introduced into a 1000-mL 4-neck flask attached with a stirrer, thermometer, dropping funnel, nitrogen inlet pipe and reflux condenser and heated until the internal temperature became 80°C, while nitrogen gas was introduced to purge oxygen. To the reaction mixture, 4.5 g of hydroxypropylcellulose and 1 g of dodecylbenzenesulfonic acid were added. Further, 0.023 g of ammonium persulfate was added as an initiator, then 12.6 g of vinyl acetate was added, and the reaction was allowed for 4 hours. Thereafter, the reaction mixture was cooled and adjusted to pH 6 with a sodium hydroxide solution to obtain Composite latex L-2.

<Preparation Example 3>

Preparation of Composite latex L-3

Composite latex L-3 was obtained in the same manner as in Preparation Example 1 except that 6.3 g of ethyl acrylate and 6.3 g of glycidyl acrylate were added instead of the vinyl pivalate.

<Example 1>

<<Preparation of Emulsion A>>

Solution 1

5	Water	750 mL
	Gelatin	20 g
	Sodium chloride	3 g
	1,3-Dimethylimidazolidine-2-thione	20 mg
	Sodium benzenethiosulfonate	10 mg
10	Citric acid	0.7 g

Solution 2

	Water	300 mL
15	Silver nitrate	150 g

Solution 3

	Water	300 mL
	Sodium chloride	38 g
	Potassium bromide	32 g
20	Potassium hexachloroiridate(III)	
	(0.005 weight % in 20 weight %	
	KCl aqueous solution)	5 mL
	Ammonium hexachlororhodate	
	(0.001 weight % in 20 weight %	
25	NaCl aqueous solution)	7 mL

The potassium hexachloroiridate(III) (0.005 weight % in

20 weight % KCl aqueous solution) and ammonium hexachlororhodate (0.001 weight % in 20 weight % NaCl aqueous solution) used for Solution 3 were prepared by dissolving powder of each in 20 weight % aqueous solution of KCl and 20 5 weight % aqueous solution of NaCl, respectively, and heating each solution at 40°C for 120 minutes.

Solution 2 and Solution 3 in amounts corresponding to 90% of each were simultaneously added to Solution 1 maintained at 38°C and pH 4.5 over 20 minutes with stirring to form nucleus 10 grains having a diameter of 0.16  $\mu\text{m}$ . Subsequently, Solution 4 and Solution 5 shown below were added over 8 minutes. Further, the remaining 10% of Solution 2 and Solution 3 were added over 2 minutes to allow growth of the grains to a diameter of 0.21  $\mu\text{m}$ . Further, 0.15 g of potassium iodide was added and ripening 15 was allowed for 5 minutes to complete the grain formation.

#### Solution 4

Water	100 mL
Silver nitrate	50 g

20

#### Solution 5

Water	100 mL
Sodium chloride	13 mg
Potassium bromide	11 mg
Potassium ferrocyanide	50 mg

25 The resulting grains were washed according to a

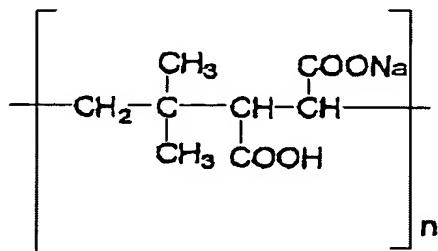
conventional flocculation method. Specifically, after the temperature of the mixture was lowered to 35°C, 3 g of Anionic precipitating agent 1 shown below was added to the mixture, and pH was lowered by using sulfuric acid until the silver halide 5 was precipitated (lowered to the range of pH 3.2 ± 0.2). Then, about 3 L of the supernatant was removed (first washing with water). Furthermore, the emulsion was added with 3 L of distilled water and then with sulfuric acid until the silver halide was precipitated. In a volume of 3 L of the supernatant 10 was removed again (second washing with water). The same procedure as the second washing with water was repeated once more (third washing with water) to complete the washing with water and desalting processes. The emulsion after the washing with water and desalting was added with 45 g of gelatin, and 15 after pH was adjusted to 5.6 and pAg was adjusted to 7.5, added with 10 mg of sodium benzenethiosulfonate, 3 mg of sodium benzenethiosulfinate, 15 mg of sodium thiosulfate and 10 mg of chloroauric acid to perform chemical sensitization at 55°C for obtaining optimal sensitivity, and then added with 100 mg of 4- 20 hydroxy-6-methyl-1,3,3a,7-tetrazaindene as a stabilizer and 100 mg of Proxcel (trade name, ICI Co., Ltd.) as an antiseptic.

There was finally obtained an emulsion of cubic silver iodochlorobromide grains containing 30 mol % of silver bromide and 0.08 mol % of silver iodide and having an average grain 25 size of 0.22 µm and a variation coefficient of 9%. The emulsion finally showed pH of 5.7, pAg of 7.5, conductivity of 40 µS/m, density of  $1.2 \times 10^3$  kg/m<sup>3</sup> and viscosity of 50 mPa•s.

The above process for Emulsion A was repeated except that the amount of sodium chloride and potassium bromide in Solutions 3 and 5, respectively, and the preparation temperature of Solutions 3 and 5 were optionally changed to 5 control the silver bromide content in the silver halide emulsion to obtain emulsions in which Br content in the halogens constituting the silver halide contained therein is 0, 40, 50, 60, 70 and 90 mol %.

10 The obtained emulsions were used in the preparation of Samples Nos. 1-18 of silver halide photographic light-sensitive materials mentioned below. Table 1 shows the Br content in the halogens constituting the silver halide contained in the emulsion used in preparation of each sample.

15 Anionic precipitating agent 1



Average molecular weight: 120,000

<<Preparation of coating solutions>>

Coating solutions for emulsion layer, upper protective layer, lower protective layer and UL layer used for preparation 20 of samples of silver halide photographic light-sensitive material were prepared by the following procedures.

(Preparation of coating solution for emulsion layer)

Emulsion A was spectrally sensitized by addition of a sensitizing dye mentioned in Table 1 in an amount of  $5.7 \times 10^{-4}$  mol/mol Ag. Further,  $3.4 \times 10^{-4}$  mol/mol Ag of KBr,  $2.0 \times 10^{-4}$  mol/mol Ag of Compound (Cpd-1),  $2.0 \times 10^{-4}$  mol/mol Ag of Compound (Cpd-2) and  $8.0 \times 10^{-4}$  mol/mol Ag of Compound (Cpd-3) were added, and the mixture was sufficiently mixed. Then,  $1.2 \times 10^{-4}$  mol/mol Ag of 4-hydroxy-6-methyl-1,3,3a,7-tetrazaindene,  $1.2 \times 10^{-2}$  mol/mol Ag of hydroquinone,  $8 \times 10^{-4}$  mol/mol Ag of a benzotriazole compound mentioned in Table 1,  $3.0 \times 10^{-4}$  mol/mol Ag of citric acid,  $2 \times 10^{-4}$  mol/mol Ag of hydrazine type nucleating agent (Cpd-4),  $90 \text{ mg/m}^2$  of 2,4-dichloro-6-hydroxy-1,3,5-triazine sodium salt, 15 weight % relative to gelatin of colloidal silica having a particle size of 10  $\mu\text{m}$ ,  $300 \text{ mg/m}^2$  of Composite latex (L-1),  $100 \text{ mg/m}^2$  of aqueous latex (aqL-6),  $150 \text{ mg/m}^2$  of polyethyl acrylate latex,  $150 \text{ mg/m}^2$  of latex of copolymer of methyl acrylate, 2-acrylamido-2-methypropanesulfonic acid sodium salt and 2-acetoxyethyl methacrylate (weight ratio = 88:5:7),  $150 \text{ mg/m}^2$  of core/shell type latex (core: styrene/butadiene copolymer (weight ratio = 37/63), shell: styrene/2-acetoxyethyl acrylate copolymer (weight ratio = 84/16), core/shell ratio = 50/50) and 4 weight % relative to gelatin of Compound (Cpd-7) were added, and the coating solution were adjusted to pH 5.6 by using citric acid.

25

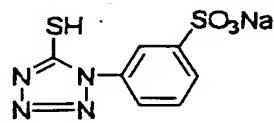
(Composition of coating solution for upper protective layer)

Gelatin	$0.3 \text{ g/m}^2$
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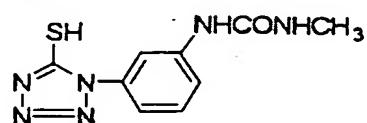
	Amorphous silica matting agent (average particle size: 3.5 $\mu\text{m}$ )	25 $\text{mg}/\text{m}^2$
	Compound (Cpd-8) (gelatin dispersion)	20 $\text{mg}/\text{m}^2$
	Colloidal silica	
5	(particle size: 10 to 20 $\mu\text{m}$ , Snowtex C, Nissan Chemical)	30 $\text{mg}/\text{m}^2$
	Compound (Cpd-9)	50 $\text{mg}/\text{m}^2$
	Sodium dodecylbenzenesulfonate	20 $\text{mg}/\text{m}^2$
	Compound (Cpd-10)	20 $\text{mg}/\text{m}^2$
10	Compound (Cpd-11)	20 $\text{mg}/\text{m}^2$
	Antiseptic (Proxcel, ICI Co., Ltd.)	1 $\text{mg}/\text{m}^2$
	(Composition of coating solution for lower protective layer)	
	Gelatin	0.5 $\text{g}/\text{m}^2$
15	Nucleation accelerator (Cpd-12)	15 $\text{mg}/\text{m}^2$
	1,5-Dihydroxy-2-benzaldoxime	10 $\text{mg}/\text{m}^2$
	Polyethyl acrylate latex	150 $\text{mg}/\text{m}^2$
	Compound (Cpd-13)	3 $\text{mg}/\text{m}^2$
	Antiseptic (Proxcel)	1.5 $\text{mg}/\text{m}^2$
20	(Composition of coating solution for UL layer)	
	Gelatin	0.5 $\text{g}/\text{m}^2$
	Polyethyl acrylate latex	150 $\text{mg}/\text{m}^2$
	Compound (Cpd-7)	40 $\text{mg}/\text{m}^2$
25	Compound (Cpd-14)	10 $\text{mg}/\text{m}^2$
	Antiseptic (Proxcel)	1.5 $\text{mg}/\text{m}^2$

Viscosity of the coating solutions for the layers was adjusted by adding Thickener Z represented by the following structure.

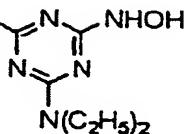
Cpd-1



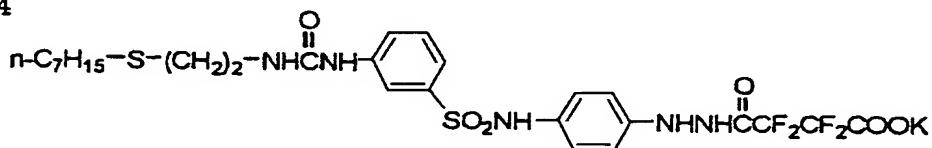
Cpd-2



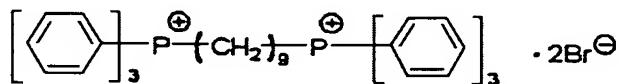
Cpd-3



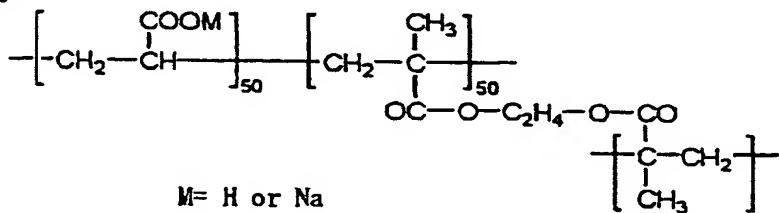
Cpd-4



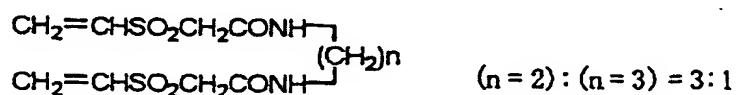
Cpd-5



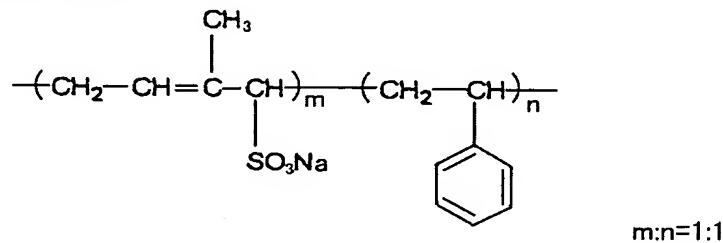
aqL-6



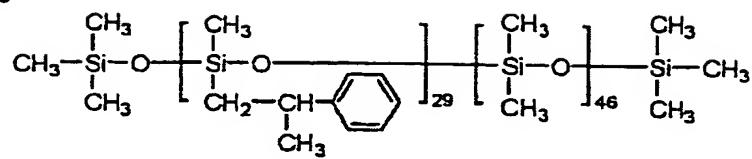
Cpd-7



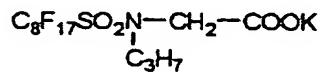
Composite latex L-1



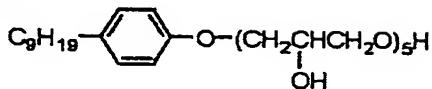
Cpd-8



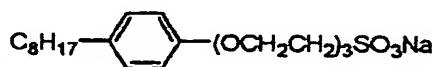
Cpd-9



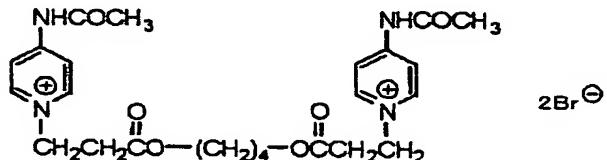
Cpd-10



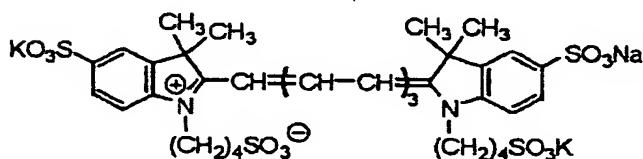
Cpd-11



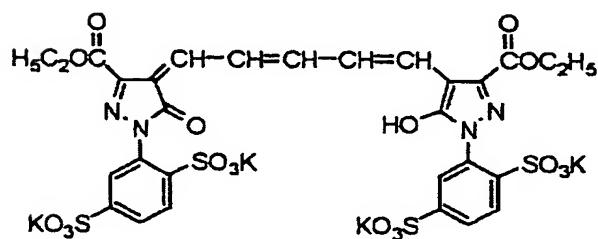
Cpd-12



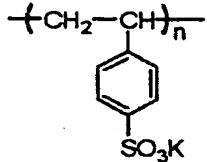
Cpd-13



Cpd-14



Thickener Z

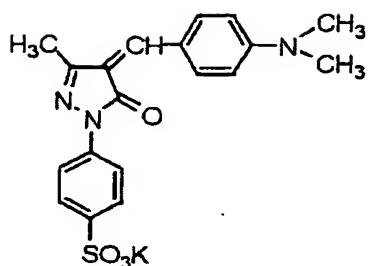


(Composition of coating solution for back layer)

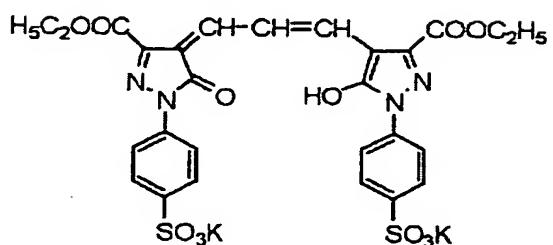
Gelatin	3.3 g/m <sup>2</sup>
5 Compound (Cpd-15)	40 mg/m <sup>2</sup>
Compound (Cpd-16)	20 mg/m <sup>2</sup>

	Compound (Cpd-17)	90 mg/m <sup>2</sup>
	Compound (Cpd-18)	40 mg/m <sup>2</sup>
	Compound (Cpd-19)	26 mg/m <sup>2</sup>
	Compound (Cpd-22)	5 mg/m <sup>2</sup>
5	Compound (Cpd-9)	10 mg/m <sup>2</sup>
	1,3-Divinylsulfonyl-2-propanol	60 mg/m <sup>2</sup>
	Polymethyl methacrylate microparticles (mean particle sizes: 6.5 µm)	30 mg/m <sup>2</sup>
	Liquid paraffin	78 mg/m <sup>2</sup>
10	Compound (Cpd-7)	120 mg/m <sup>2</sup>
	Calcium nitrate	20 mg/m <sup>2</sup>
	Antiseptic (Proxcel)	12 mg/m <sup>2</sup>

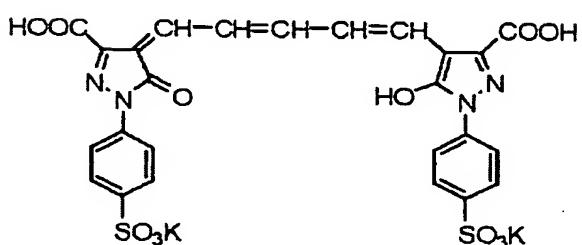
Cpd-15



Cpd-16



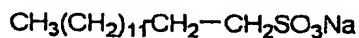
Cpd-17



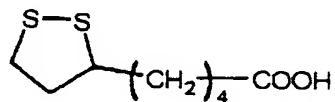
Cpd-18



Cpd-19



Cpd-22



<<Preparation of support>

Undercoat layers and conductive layer were coated on a biaxially stretched polyethylene terephthalate support

(thickness: 100  $\mu\text{m}$ ) as described below.

The both surfaces of the support were subjected to a corona discharge treatment at  $8 \text{ W}/(\text{m}^2 \cdot \text{min})$ , then the coating solution for Undercoat layer B-1 was coated in a dry thickness of 0.8  $\mu\text{m}$  on the emulsion layer side of the support to form Undercoat layer B-1, and the coating solution for Undercoat layer B-2 was coated in a dry thickness of 0.8  $\mu\text{m}$  on the back layer side of the support to form Undercoat layer B-2.

10 (Composition of coating solution for Undercoat layer B-1)

Latex solution (solid content: 30%) 270 g

(copolymer of 30 weight % of butyl acrylate,

20 weight % of tert-butyl acrylate,

25 weight % of styrene and 25 weight %

15 of 2-hydroxyethyl acrylate)

Compound (UL-1) 0.6 g

Hexamethylene-1,6-bis(ethylene urea) 0.8 g

Water Amount giving

20 total volume  
of 1000 mL

(Composition of coating solution for Undercoat layer B-2)

Latex solution (solid content: 30%) 270 g

(copolymer of 40 weight % of butyl acrylate,

25 20 weight % of styrene and 40 weight %

of glycidyl acrylate)

Compound (UL-1) 0.6 g

Hexamethylene-1,6-bis(ethylene urea)	0.8 g
Water	Amount giving total volume of 1000 mL

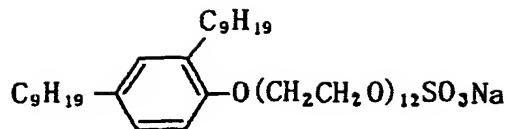
5

Furthermore, Undercoat layer B-2 was subjected to a corona discharge treatment at  $8 \text{ W}/(\text{m}^2 \cdot \text{min})$ , and Coating solution A for conductive layer mentioned below was coated in a dry thickness of  $0.8 \mu\text{m}$  on Undercoat layer B-2 to form a conductive  
10 layer.

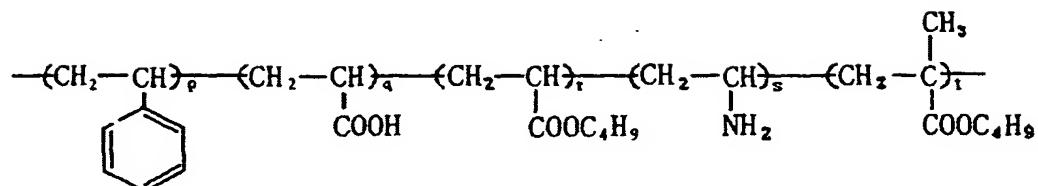
(Composition of Coating solution A for conductive layer)

Conductive polymer P-5	60 g
Latex solution containing Compound (UL-2)	
15 as component (solid content: 20%)	80 g
Ammonium sulfate	0.5 g
Curing agent (UL-3)	12 g
Polyethylene glycol	
(weight average molecular weight: 600)	6 g
20 Water	Amount giving total volume of 1000 mL

UL-1

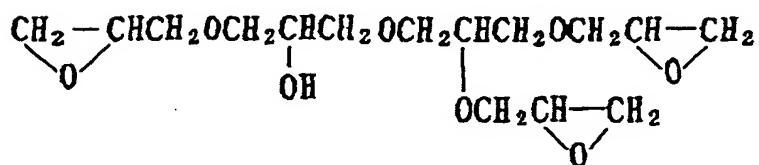
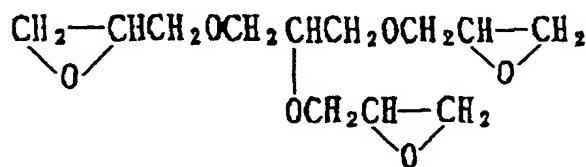


UL-2



$\text{p} : \text{q} : \text{r} : \text{s} : \text{t} = 40 : 5 : 10 : 5 : 40$  (weight ratio)

UL-3



Mixture of the three compounds

<<Coating method for applying coating solutions on support>>

First, on the emulsion layer side of the aforementioned support coated with the undercoat layers, four layers of UL

layer, emulsion layer, lower protective layer and upper protective layer were simultaneously coated as stacked layers in this order from the support at 35°C by the slide bead coating method and passed through a cold wind setting zone

5 (5°C). Then, on the side opposite to the emulsion layer side, a conductive layer and a back layer were simultaneously coated as stacked layers in this order from the support by the curtain coating method with adding a hardening agent solution, and passed through a cold wind setting zone (5°C). When the coated support was passed through each setting zone, the coating solutions showed sufficient setting. Subsequently, the support coated with the layers was dried for the both surfaces in a drying zone of the drying conditions mentioned below. The coated support was transported without any contact with rollers

10 and the other members after the coating of the back surface until it was rolled up. The coating speed was 250 m/min. The coating solution for emulsion layer was coated so that the coated silver amount and coated gelatin amount should become 2.9 g/m<sup>2</sup> and 1.5 g/m<sup>2</sup>, respectively.

15

20

<<Drying conditions>>

After the setting, the coated layers were dried with a drying wind at 30°C until the water/gelatin weight ratio became 800%, and then with a drying wind at 35°C and 30% relative humidity for the period where the ratio became 200% from 800%. The coated layers were further blown with the same wind, and 30 second after the point where the surface temperature became

34°C (regarded as completion of drying), the layers were dried with air at 48°C and 2% relative humidity for 1 minute. In this operation, the drying time was 50 seconds from the start of the drying to the point that the water/gelatin ratio became 800%,

5 35 seconds for a period that the ratio changed from 800% to 200% of the ratio, and 5 seconds from the point that the ratio was 200% to the end of the drying.

<<Preparation of samples>>

10 This silver halide photographic light-sensitive material was rolled up at 25°C and 55% relative humidity, cut under the same conditions, conditioned for moisture content at 25°C and 50% relative humidity for 8 hours and sealed in a barrier bag conditioned for moisture content for 6 hours together with a  
15 cardboard conditioned for moisture content at 25°C and 50% relative humidity for 2 hours to prepare a sample.

Humidity in the barrier bag was measured and found to be 45%. The obtained sample had a film surface pH of 5.5 to 5.8 for the emulsion layer side and 6.0 to 6.5 for the back side.

20 The absorption spectra for the emulsion layer side and the back layer side are shown in Fig. 1.

Surface resistivity of the silver halide photographic light-sensitive material of the present invention was measured and found to be  $3 \times 10^{11} \Omega$ . The surface resistivity was obtained  
25 as follows. The silver halide photographic light-sensitive material was left under an environment of 25°C and 25% relative humidity for 12 hours, and then inserted between stainless

steel electrodes having a length of 10 cm disposed with a distance between the electrodes of 0.14 cm. An electrometer TR8651 produced by Takeda Riken was used to measure a value at a voltage of 100 V 1 minute after.

5        According to the aforementioned method, 18 kinds of samples of silver halide photographic light-sensitive materials mentioned in Table 1 were prepared. As for the benzotriazole compound and sensitizing dye used in the preparation of Emulsions A, each of those mentioned in Table 1 was selected.

10      The halogen compositions of the coated emulsions mentioned in Table 1 were controlled by changing the amounts of sodium chloride and potassium bromide contained in Solutions 3 and 5 used for Emulsions A, preparation temperature and so forth.

15      <<Processing in automatic processor>>

      In the processing utilizing an automatic processor performed in this example, the following fixer was used.

20      Composition of Fixer (B) (composition per liter of concentrated solution)

Ammonium thiosulfate	360 g
Disodium ethylenediaminetetraacetate dihydrate	0.09 g
Sodium thiosulfate pentahydrate	33.0 g
25      Sodium metasulfite	57.0 g
Sodium hydroxide	37.2 g
Acetic acid (100%)	90.0 g

Tartaric acid	8.7 g
Sodium gluconate	5.1 g
Aluminum sulfate	25.2 g
pH 4.85	

5

The above concentrated solution and water were mixed in a volume ratio of 1:2 upon use. pH of the solution used was 4.8.

A running test was performed with a combination of each of the light-sensitive materials mentioned in Table 1 and

10 Developer (A) mentioned below.

Developer (A) (composition per liter of concentrated solution)

Water	600 mL
Potassium hydroxide	105.0 g
15 Diethylenetriaminepentaacetic acid	6.0 g
Potassium carbonate	120.0 g
Sodium metabisulfite	120.0 g
Potassium bromide	9.0 g
Hydroquinone	75.0 g
20 5-Methylbenzotriazole	0.24 g
4-Hydroxymethyl-4-methyl-1-phenyl-	
3-pyrazolidone	1.35 g
Sodium 2-mercaptobenzimidazole-5-	
sulfonate	0.432 g
25 4-(N-carboxymethyl-N-methylamino)-	
2,6-dimercaptopyrimidine	0.18 g
2-(N-carboxymethyl-N-methylamino)-	

4,6-dimercaptopyrimidine	0.06 g
Sodium erysorbate	9.0 g
Diethylene glycol (DEG)	60.0 g

5 The volume was made 1 L, and pH was adjusted to 10.7 by adding potassium hydroxide and water.

A starter solution (mother solution) was prepared by mixing the above concentrated solution and water in a volume ratio of 1:3 (pH 10.4). A replenisher was prepared by mixing 10 the above concentrated solution and water in a volume ratio of 1:2 (pH 10.45). The replenishing amount was 100 mL per one sheet of Daizen (large sheet) size (50.8 × 61.0 cm) or 323 mL per 1 m<sup>2</sup>.

15 <<Evaluation>>

[Evaluation of practice density and dot %]

On the light-sensitive materials prepared in this example, test steps were outputted by using an image setter RC5600V produced by Fuji Photo Film Co., Ltd. at 175 lines/inch with 20 changing the light quantity and developed by using AP-560 produced by Fuji Photo Film Co., Ltd. as an automatic processor and the developer mentioned above with the conditions of development temperature of 35°C and development time of 30 seconds. Density of a D<sub>max</sub> portion obtained by exposure at an 25 LV value giving 50% of medium half tone dots was measured as practice density (D<sub>m</sub>). The dot % and the practice density were measured by using a densitometer (Macbeth TD904). Considering

the subsequent processes, a practice density of 4.0 or more is necessary, and it is preferably 4.0 to 5.0. As for the dot %, the dot % fluctuation is preferably  $\pm 3\%$  after running with 50% fresh solution.

5

[Evaluation of running property]

The light-sensitive material subjected to exposure giving 50% of medium half tone dots used in the evaluation of practice density was processed in an amount of  $5 \text{ m}^2$  per day with 10 replenishing amount of  $323 \text{ mL/m}^2$  for the developer and fixer, and this running was continued for one month. Then, practice  $D_m$  and dot % were evaluated.

[Evaluation of uneven processing]

15 An LV value giving 90% of half tone dot % in the exposure method used in the aforementioned image setter was determined to output a tint. This exposed sample was processed with a fresh solution or a solution after running, and unevenness of the processing was evaluated according to 5-stage criteria.  
20 Score 5 means no unevenness of processing, Score 3 means a scarcely usable level in spite of presence of slight unevenness of processing, and Score 1 means generation of serious unevenness of processing, i.e., no value as a commercial product.

25

[Evaluation of residual color]

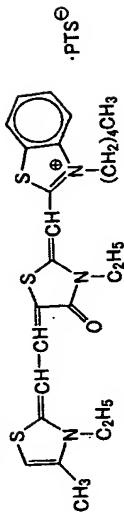
Evaluation was performed by visual inspection for 5

sheets of stacked unexposed areas of samples after the processing of the final day of the running. The residual color was evaluated according to 5-stage criteria. Score 1 means a level of extremely bad residual color property, and Score 5 means a level of no residual color. Score 3 means a scarcely usable level in spite of presence of residual color. The results are shown in Table 1.

Table 1

Sample No	Halogen composition (Br content, mol%)	Benzotriazole compound No.	Sensitizing dye No.	Evaluation of performance						Note	
				Fresh				After running			
				Dm	Dot %	Uneven processing	Dm	Dot %	Uneven processing		
1	0	3	I-1	4.70	50	1	4.30	51	1	4 Comparative	
2	30	3	Comparative dye	4.69	50	2	4.35	52	2	2 Comparative	
3	30	3	I-1	4.65	50	2	4.52	51	2	5 Comparative	
4	30	-	I-1	4.21	50	2	3.95	54	1	4 Comparative	
5	40	3	I-1	4.58	50	4	4.55	51	3	4 Invention	
6	40	3	Comparative dye	4.56	50	4	4.51	52	4	2 Comparative	
7	50	-	II-14	4.30	50	3	3.98	55	3	4 Invention	
8	50	3	II-14	4.61	50	4	4.58	51	4	5 Invention	
9	50	3	I-1	4.54	50	4	4.49	51	4	4 Invention	
10	50	17	I-1	4.51	50	4	4.40	50	3	4 Invention	
11	50	-	III-2	4.28	50	4	3.89	54	4	4 Invention	
12	50	3	III-2	4.53	50	5	4.50	51	4	5 Invention	
13	50	-	IV-21	4.35	50	4	3.95	53	4	4 Invention	
14	50	3	IV-21	4.56	50	4	4.51	51	3	4 Invention	
15	50	17	IV-21	4.55	50	4	4.48	51	4	4 Invention	
16	60	3	I-1	4.45	50	5	4.38	50	5	4 Invention	
17	70	3	I-1	4.31	50	4	4.25	51	4	4 Invention	
18	90	3	I-1	4.24	50	5	4.20	51	5	4 Invention	

Comparative dye



From the results shown in Table 1, it was found that the light-sensitive materials satisfying the requirements of the present invention exhibited favorable photographic properties  
5 (practice D<sub>m</sub> and half dot % fluctuation) and high evaluation scores for residual color and uneven processing after the running.

In the step of washing with water in the automatic processor, AC-1000 produced by Fuji Photo Film Co., Ltd. was  
10 used as a water-saving and scale-preventing apparatus, and AB-5 produced by Fuji Photo Film Co., Ltd. was used as a chemical in combination. The replenishing amount was 1 L per one sheet of Daizen size (50.8 × 61.0 cm).

15 <Example 2>

The same experiment as that of Example 1 was performed by using the same solutions as those used in Example 1 as fresh solutions (start solutions), a replenisher having the same composition as those used in Example 1 except for DEG, and a  
20 solid developer and solid fixer densely filled in a polyethylene container in the following layer structures. As a result, the samples satisfying the requirements of the present invention showed favorable performances as in Example 1.

25 Developer

First layer	Hydroquinone
Second layer	Other ingredients

Third layer	KBr
Fourth layer	Na <sub>2</sub> S <sub>2</sub> O <sub>5</sub>
Fifth layer	Potassium carbonate
Sixth layer	KOH pellets

5

This composition was dissolved to a volume of 3 L and used.

**Fixer**

10	First layer	(NH <sub>4</sub> ) <sub>2</sub> S <sub>2</sub> O <sub>3</sub> /Na <sub>2</sub> S <sub>2</sub> O <sub>5</sub> /SS	160.0 g
	Second layer	Na <sub>2</sub> S <sub>2</sub> O <sub>5</sub>	15.0 g
	Third layer	Anhydrous sodium acetate	32.7 g
	Fourth layer	Ethylenediaminetetraacetic acid	0.03 g
		Succinic acid	3.3 g
15		Tartaric acid	3.0 g
		Sodium gluconate	1.8 g
	Fifth layer	Ammonium alum	23.0 g
	pH in 1 L of the used solution		4.80

20 <Example 3>

The same experiment as that of Example 1 was performed by using Sample Nos. 2 and 4 prepared in Example 1 and Developers (B), (C), (D) and (E) mentioned below.

25 Developer (B)

Water	600 mL
Potassium hydroxide	96.0 g

	Diethylenetriaminepentaacetic acid	6.0 g
	Potassium carbonate	48.0 g
	Sodium metabisulfite	120.0 g
	Potassium bromide	9.0 g
5	Hydroquinone	70.0 g
	5-Methylbenzotriazole	0.24 g
	1-Phenyl-3-pyrazolidone	1.7 g
	2-Mercaptobenzothiazole	0.18 g
	1-Phenyl-5-mercaptotetrazole	0.06 g
10	Sodium erythorbate	9.0 g
	Diethylene glycol	40.0 g

Potassium hydroxide and water were added to a volume of 1 L so that pH should become 10.8.

15 The above solution and water were mixed in a volume ratio of 1:2 to prepare the solution used (pH was 10.45). The replenishing amount was 100 mL per one sheet of Daizen size (50.8 × 61.0 cm) or 323 mL per 1 m<sup>2</sup>.

20 Developer (C)

	Water	600 mL
	Potassium hydroxide	6.0 g
	N-(2-Hydroxyethyl)-	
	ethylenediaminetriacetate 3Na	2.0 g
25	Potassium carbonate	23.0 g
	Potassium sulfite	65.0 g
	Potassium bromide	10.0 g

Hydroquinone	21.0 g
1-Phenyl-5-mercaptotetrazole	0.03 g
1-Phenyl-3-pyrazolidone	0.4 g
Diethylene glycol	25.0 g

5

Water was added to a volume of 1 L, and pH was adjusted to 10.48.

Developer (D)

10	Water	600 mL
	Potassium hydroxide	22.0 g
	Diethylenetriaminepentaacetic acid	3.0 g
	Potassium carbonate	22.0 g
	Sodium metabisulfite	45.0 g
15	Boric acid	5.6 g
	Potassium bromide	4.4 g
	Hydroquinone	25.0 g
	4-Hydroxymethyl-4-methyl-1-	
	phenyl-3-pyrazolidone	0.8 g
20	1-Phenyl-5-mercaptotetrazole	0.02 g
	Benzotriazole	0.2 g
	Diethylene glycol	40.0 g

Water was added to a volume of 1 L, and pH was adjusted to 10.41.

Developer (E)

	Water	600 mL
	Potassium hydroxide	17.0 g
	Disodium ethylenediaminetetraacetate dihydrate	2.0 g
5	Potassium carbonate	15.0 g
	Potassium metabisulfite	25.0 g
	Potassium bromide	5.0 g
	Hydroquinone	12.0 g
	1-Phenyl-3-pyrazolidone	0.2 g

10

Water was added to a volume of 1 L, and pH was adjusted to 10.05.

The results of the experiment are shown in Table 2.

15

Table 2

Sample No.	Developer No.	Fresh			After running			Note
		Dm	Dot %	Uneven processing	Dm	Dot %	Uneven processing	
2	B	4.46	50	2	4.12	53	2	2
2	C	4.41	50	2	4.07	52	2	Comparative
2	D	4.53	50	2	4.01	53	2	Comparative
2	E	4.39	50	2	4.03	52	2	Comparative
9	B	4.52	50	5	4.33	51	4	5
9	C	4.61	50	4	4.35	52	4	Invention
9	D	4.56	50	4	4.29	51	4	Invention
9	E	4.53	50	5	4.22	51	4	Invention

From the results shown in Table 2, it was found that the silver halide photographic light-sensitive materials satisfying the requirements of the present invention exhibited favorable photographic properties (practice  $D_m$  and dot % fluctuation) and 5 high evaluation scores for residual color and uneven processing after the running.

<Example 4>

The same experiments as those of Examples 1 to 3 were 10 performed except that the development temperature was changed to 38°C, fixing temperature to 37°C and developing time to 20 seconds. The results were similar to those obtained in Examples 1 to 3, and thus superior performance of the light-sensitive materials satisfying the requirements of the present invention 15 was confirmed.

<Example 5>

The same experiments as those of Examples 1 to 4 were performed except that FG-680AS produced by Fuji Photo Film Co., 20 Ltd. was used as the automatic processor, and the transportation speed of the light-sensitive materials was adjusted to 1500 mm/minute as a linear speed. As a result, results similar to those of Examples 1 to 4 were obtained, and thus superior performance of the light-sensitive materials 25 satisfying the requirements of the present invention was confirmed.

<Example 6>

The same evaluation of practice density as in Examples 1 to 5 was performed after the same running as described above by using, instead of Lux Setter RC-5600V produced by Fuji Photo Film Co., Ltd, any one of Image setter FT-R5055 produced by Dainippon Screen Mfg. Co., Ltd., Select Set 5000, Avantra 25 and Acuset 1000 produced by Agfa Gevaert AG, Dolev 450 and Dolev 800 produced by Scitex, Lino 630, Quasar, Herkules ELITE and Signasetter produced by Heidelberg, Luxel F-9000, and 10 Panther Pro 62 produced by PrePRESS Inc. As a result, results similar to those of Examples 1 to 5 were obtained, and thus superior performance of the light-sensitive materials satisfying the requirements of the present invention was confirmed.

15

<Example 7>

The same experiment as in Example 1 was performed except that the hydrazine compounds contained in the light-sensitive materials were changed to D-68 or D-69. As a result, results 20 similar to those of Example 1 were obtained, and thus superior performance of the light-sensitive materials satisfying the requirements of the present invention was confirmed.

<Example 8>

25 The same experiment as that of Example 1 was performed by changing the composition of the conductive layer to the following composition. As a result, results similar to those of

Example 1 were obtained, and thus superior performance of the light-sensitive materials satisfying the requirements of the present invention was confirmed. The surface resistivity of the silver halide light-sensitive materials prepared in Example 8  
5 was  $1 \times 10^{10} \Omega$  in an atmosphere of 25°C and 25% of relative humidity.

(Composition of coating solution for conductive layer)

Gelatin	0.1 g/m <sup>2</sup>
10 Sodium dodecylbenzenesulfonate	20 mg/m <sup>2</sup>
SnO <sub>2</sub> /Sb (weight ratio = 9:1, average particle size: 0.25 μm)	200 mg/m <sup>2</sup>
Antiseptic (Proxcel, ICI Co., Ltd.)	0.3 mg/m <sup>2</sup>

15 <Example 9>

Samples were prepared in the same manner as that of Example 1 except that Conductive polymer P-5 in Coating solution A for conductive layer used for the preparation of Sample Nos. 5, 8, 12, 14 and 16 was changed to Polymer P-12, P-  
20 18 or P-21, and the same evaluations as those of Example 1 were performed. As a result, it was confirmed that they exhibited favorable photographic properties (practice Dm and dot % fluctuation) and high evaluation scores for residual color and uneven processing after the running as in Example 1.

25

If the silver halide photographic light-sensitive material of the present invention, of which silver amount is

reduced, is exposed with an image setter and then processed in an automatic processor, stable photographic performance can be obtained while ameliorating the problems of uneven processing and residual color property. Therefore, the silver halide  
5 photographic light-sensitive material of the present invention is suitable for use in scanners and image setters utilizing HeNe laser, red semiconductor laser or LED as a light source.

The present disclosure relates to the subject matter  
10 contained in Japanese Patent Application No. 26652/2003 filed on February 4, 2002, which is expressly incorporated herein by reference in its entirety.

The foregoing description of preferred embodiments of the invention has been presented for purposes of illustration and  
15 description, and is not intended to be exhaustive or to limit the invention to the precise form disclosed. The description was selected to best explain the principles of the invention and their practical application to enable others skilled in the art to best utilize the invention in various embodiments and  
20 various modifications as are suited to the particular use contemplated. It is intended that the scope of the invention not be limited by the specification, but be defined claims set forth below.